

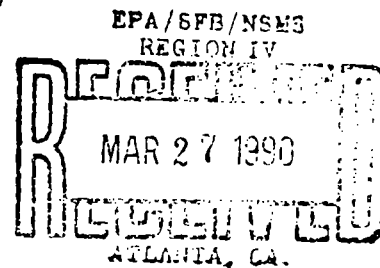
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FEASIBILITY STUDY REPORT
SCRDI-BLUFF ROAD SITE
COLUMBIA, SOUTH CAROLINA

Prepared for:
THE BLUFF ROAD GROUP

MARCH 1990

DRAFT



AMENDMENT 1

1. On page ES-4 a range of volumes is given for the volume of soil estimated to require remediation. This range should be 16,000 cubic yards to 45,000 cubic yards as was provided the Agency in its initial inquiry as to the lowest estimate of soil to be remediate.

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ACRONYMS

1,1-DCA	1,1-dichloroethane
1,1,2,2-TCA	1,1,2,2-tetrachloroethane
ADI	Allowable daily intake
AEI	Average exposed individual
AIC	Acceptable intake for chronic exposure
ARARS	Applicable or relevant and appropriate requirements
ATSDR	Agency for Toxic Substances and Disease Registry
BEHP	bis (2-ethylhexyl) phthalate
CAA	Clean Air Act
CAG	Carcinogen Assessment Group
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CPFs	Cancer potency factors
EPA	U.S. Environmental Protection Agency
ESRI	Earth Sciences Resource Institute
FDA	Food and Drug Administration
FS	Feasibility Study
gpm	Gallons per minute
HI	Hazard Index
IRIS	Integrated Risk Information System
IT	IT Corporation
MCLs	Maximum concentration limits
MEI	Maximum exposed individual
MOEI	Maximum occupationally exposed individual
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NESHAP	National Emission Standards for Hazardous Air Pollutants
NOAEL	No observed adverse effects level
NPDES	National Pollutant Discharge Elimination System
PCB	Polychlorinated biphenyl
PCE	Tetrachloroethylene

ACRONYMS (continued)

POTW	Publicly owned treatment works
ppm	Parts per million
PRPs	Potentially responsible parties
RI	Remedial Investigation
SARA	Superfund Amendments and Reauthorization Act of 1986
SCDHEC	South Carolina Department of Health and Environmental Control
scfm	Standard cubic feet per minute
SCRDI	South Carolina Recycling and Disposal Inc.
TBC	To-be-considered (materials)
USGS	United States Geological Survey
VOCs	Volatile organic compounds

EXECUTIVE SUMMARY

The SCRDI (Bluff Road Site) is located in Richland County, South Carolina and is approximately 10 miles south of the City of Columbia on the north side of State Highway 48. The Site is ranked 83rd on the National Priorities List (NPL) by the U.S. Environmental Protection Agency (EPA) under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). The site is also listed as the top priority site in the State of South Carolina.

This Feasibility Study (FS) report presents and summarizes the process used to develop remedial action alternatives for the SCRDI-Bluff Road Site. The evaluation of alternatives is based on the information and data presented in the approved Remedial Investigation (RI) report (IT Corp., 1989).

A Feasibility Study uses a step-by-step evaluation of technologies, alternatives and assembled alternatives by progressing through a series of screenings. The initial technology screening uses qualitative information to assess effectiveness and implementability of a technology with respect to prevention or mitigation of a release or threatened release from the site. Retained technologies are then evaluated against specified criteria using quantitative information to identify feasible and appropriate technologies. The FS provides a conceptual basis for remedial action alternatives and is not intended to present design level detail.

The objective of technology evaluation is to establish alternatives that are protective of human health and the environment, attain Federal and State requirements that are

legally applicable or relevant and appropriate and are cost-effective. The alternatives should, to the maximum extent practicable, meet the statutory preference to employ in-situ, on-site treatment that reduces toxicity, mobility or volume.

SITE CHARACTERISTICS

The site is a rectangular parcel of land measuring 133 feet of frontage on Bluff Road (Highway 48), and extending back from the road approximately 1,300 feet. The site is relatively level with ground elevation varying from approximately 139 feet [United States Geological Survey (USGS) datum] near the highway to 134 feet above mean sea level at the rear of the property. The front portion of the site, approximately 600 feet from the road, is cleared and has been used for various industrial and commercial purposes. The back portion of the site, encompassing one half of the area is heavily wooded.

The soils identified in the project by the Richland County Soil Survey include loams, which are mixtures of sand, silt, and clay. The specific soil types present in the vicinity of the site are Orangeburg loamy sand, Persanti very fine sand loams, Smithboro loam, and Cantry loam. A low permeability surface clay layer was predominant in areas adjacent to the site. However, based on soil borings by Golder and IT Corporation, this surficial clay layer was absent on the site, specifically in areas potentially identified for soil remediation. This is confirmed by the absence of standing water in these areas and lack of subsurface saturated conditions as determined by the borings.

The local hydrogeology pertinent to the Site is defined by a surficial aquifer and a deep aquifer with the two formations separated within the area encompassed by well installation by a clay aquitard. This clay layer was present at 41 out of 41 well installations and can be correlated between locations. The shallow aquifer typically extends to a depth of 45 to 50 feet and is composed primarily of sands which range from coarse and well sorted to silty and poorly sorted. The ground water table in the shallow aquifer generally lies 10 to 15 feet below ground surface based on the three rounds of ground water level measurements taken. The deep aquifer is separated from the shallow aquifer by a clay and silt unit which ranges in thickness from 1.5 to 25 feet. This partial confining layer is thinnest upgradient of the Site and thickens to the south and west. The lithology of the deep aquifer is similar to that of the shallow aquifer, though clay-rich layers are more common. Both the clay aquitard and the deep aquifer are thought to be units in the Black Creek Formation.

A portion of the Bluff Road Site and nearby property was recently classified by the Corps of Engineers as a wetlands. Impact to wetlands resulting from remedial actions should be avoided. Where no other practical alternative is available any impacts to wetlands should be mitigated.

NATURE AND EXTENT OF CONTAMINATION

Elevated levels of site-related compounds at the SCRDI site are limited to the on-site soils and the shallow ground water aquifer.

A shallow aquifer plume, consisting primarily of volatile organic compounds, encompasses an area of approximately 1000 feet by 2200 feet over the depth of the surficial aquifer of

40 feet. This correlates to an approximate volume of 263,369,000 gallons.

Localized areas of soil contamination provide the potential for continuing sources for degradation of the ground water. The estimated volume of impacted soils is expected to be 28,000 to 45,000 cubic yards, based on approximately 10 feet of unconsolidated material above the true surficial aquifer water table and a maximum area on the cleared portion of the property of approximately 2.6 acres. Significant compounds detected in site surface and subsurface soils consist primarily of volatile and some semi-volatile materials.

Analytical results for on-site and off-site surface water and surface water sediment indicated no significant site-related contamination.

Ambient air sampling showed no site-related impact.

SITE RISK ASSESSMENT SUMMARY

A baseline risk assessment was performed as part of the Remedial Investigation to evaluate the potential for off-site migration of constituents from the site and the impacts on public health and/or the environment. The baseline risk is associated with the No-Action Alternative.

The extent of constituents in environmental media at the SCRDI site was shown to be limited to the on-site soils and shallow ground water aquifer underlying the site. Elevated levels of site related constituents were not found in off-site soil samples, sediment or water samples from drainage ditches, the deep ground water aquifer, or in surface water in local creeks. The primary potential route of off-site migration was shown to be via the shallow ground water aquifer. This

aquifer may recharge Myers Creek, 3,200 feet northeast of the site boundary. However, site-related constituents have not been detected in Myers Creek.

Based on a future use scenario, direct consumption of ground water from the surficial aquifer within the contaminant plume would present potential unacceptable levels of exposure. A well survey showed no known domestic wells within the study area that draw from the shallow aquifer. A future use trespasser scenario indicated that the presence of site-related constituents in the soils do not present a potential risk to the health of adult or child trespassers on the site.

The predicted constituent concentrations in Myers Creek that could result from direct undiluted discharge of the plume into the creek would not have a significant impact upon the indigenous aquatic populations. The predicted chemical concentrations in Myers Creek are over three orders of magnitude lower than the respective maximum acceptable toxicant concentrations (MATCs) for the most sensitive species which may be found in Myers Creek.

The effects or potential for bioconcentrations or bioaccumulation were determined by the USEPA to be negligible at the Site.

DEVELOPMENT AND SCREENING OF REMEDIAL TECHNOLOGIES AND POTENTIAL ALTERNATIVES

Applicable general response actions and remedial action objectives and technologies addressing surficial aquifer and soil contamination at the Site were identified. Remedial technologies were screened according to applicability to site contaminants and conditions, the effectiveness of the

technology in meeting the remedial action objectives and implementability with respect to site-specific physical and chemical characteristics. Based on the initial screening, the following alternatives or assembled alternatives were retained for detailed analysis to address on-site soils and the shallow ground water aquifer.

- o No Action (statutory requirement);
- o Ground water extraction and treatment by air stripping
- o Ground water extraction and treatment by liquid phase carbon adsorption;
- o In-situ soil venting;
- o On-site thermal desorption of soils;
- o On-site incineration of soils;
- o Off-site incineration of soils; and
- o Off-site disposal of soils.

DESCRIPTION OF RETAINED ALTERNATIVES

Based on screening and detailed analysis of remedial alternatives for the Bluff Road Site, several assembled remedial alternatives, including the No Action alternative, were developed. The following descriptions represent a range of remedial actions applicable to the Bluff Road Site. Institutional controls and ground water sampling and analysis will be the same for each alternative. The surficial aquifer is classified GB, potable water supply, by the State of South Carolina.

No Action

The no action alternative would not utilize any active remedial technology to address the shallow aquifer or soils contamination, but rather the natural attenuation/degradation provided by environmental factors. Institutional controls, such as access and deed restrictions, would also be implemented. In addition, ground water sampling and analysis would be conducted

for the upper and lower aquifers to monitor any migration (horizontal or vertical) of the ground water plume.

The no action alternative is required by the NCP and provides the baseline for comparison of other alternatives. The estimated present worth for the no action alternative is \$760,000.

Ground water Extraction and Liquid Phase Carbon Adsorption

This alternative consists of a ground water extraction system designed to remove constituents and mitigate migration (i.e., containment component). The extracted ground water is treated to remove constituents by using a granular activated carbon system for liquid phase removal of organics. The carbon is subsequently changed out and treated to destroy the retained organics.

A pretreatment system such as precipitation/flocculation, is included as a retained process alternative based on the characteristics of the surficial aquifer, (i.e., iron and manganese content).

Based on the time required to pump three pore volumes at 100 gpm, the estimated time for implementation is 15.03 years at a present worth cost of \$16,105,000. The capital cost is \$1,390,000 and the annual O&M cost is \$1,357,125.

Ground Water Extraction and Air Stripping with Off-gas Control by Vapor Phase Carbon Adsorption

This alternative consists of a ground water extraction system designed to remove constituents and mitigate migration. The extracted ground water is treated to remove constituents by air stripping. The more volatile components of the ground water would be removed by air stripping. A liquid phase granular activated carbon system is used to treat the air stripper liquid effluent to remove less volatile compounds, (i.e. semi-volatiles). A pretreatment system will be evaluated in design to remove metals prior to stripping and liquid phase carbon treatment. The stripper off-gas (potential air emissions) will be treated with a vapor phase activated carbon system to mitigate potential air emissions impact. The carbon of both the vapor and liquid phase systems is changed out as needed and is treated to destroy the retained organics.

The estimated time for implementation is 15.03 years at a present worth cost of \$4,339,500. The capital cost is \$1,013,000 and the annual O&M cost is \$306,875.

Effluent Discharge Alternatives

Several alternatives were evaluated for treated ground water discharge. As a result of the recent classification by the Corps of Engineers of the area adjacent to the Site as a wetland, a complete assessment of appropriate options could not be performed. The following alternatives will be evaluated during design for either the most appropriate or possibly the only option available:

- o Subsurface Injection: Infiltration galleries are a proven and reliable alternative for effluent discharge. The effectiveness of this alternative is dependent on vadose zone acceptance of the treated ground water. Subsurface percolation testing must be performed to determine permissible application rates and to establish the most appropriate process alternative (i.e., horizontal or vertical). The infiltration gallery must be located so that recharge to the aquifer does not interfere with the performance of the extraction system.

Discharge limitations for subsurface infiltration of the treated ground water would be the aquifer target cleanup levels. This effluent discharge option would establish the discharge design requirements for the ground water treatment system.

The total present worth cost for the infiltration gallery effluent discharge alternative would be approximately \$165,484. The capital cost is \$117,656 and the annual O&M cost is \$4412.

- o Discharge to Myers Creek: This is a South Carolina Class A Stream. Design effluent concentrations are acceptable to meet appropriate ambient water quality criteria. The impact associated with classification of this area as a wetlands and potential downstream flooding must be established as part of remedial design. Estimated total present worth cost is \$422,136. The capital cost is \$204,758 and the annual O&M cost is \$20,053.

- o Discharge to the Congaree River: This is a South Carolina Class A stream. Design effluent concentrations are acceptable to meet appropriate ambient water quality criteria. The impact of extensive overland piping on a wetlands area and associated requirements for access agreements and easements must be evaluated in remedial design. Estimated total present worth cost is \$3,321,069. The capital cost is \$1,883,873 and the annual O&M cost is \$132,583.
- o Spray Irrigation: As a result of the wetlands classification, the potential of ground water pumping to impact the wetlands surficial hydrology could be significant. This must be evaluated during the design phase. Treatment system design would have to mitigate any impact. This mitigation could either be addressed by reduced pumping rates (i.e., that required to maintain plume containment) or by unique handling of treated ground water for recharge of the wetland surface. Estimated total present worth cost is \$452,685. The capital cost is \$194,685 and the annual O&M cost is \$23,801. Detailed costing will be established during design if any of the alternatives presented are determined to be implementable.

Soil treatment was evaluated based on potential impact of continuing sources on degradation of the surficial aquifer. Soil treatment would be performed in conjunction with any ground water remediation.

In-situ Soil Venting with Vapor Phase Activated Carbon Emissions Control

Soil venting is an in-situ treatment process used to treat soils that contain volatile and some semi-volatile organic compounds. The process utilizes extraction wells to induce a vacuum on subsurface soils. The subsurface vacuum propagates laterally, causing in-situ volatilization of compounds that are adsorbed to soils. Vaporized compounds and subsurface air migrate rapidly to extraction wells, essentially air stripping the soils in-place. Creation of subsurface aerobic conditions increases biological activity with respect to lower vapor pressure compounds. This, in conjunction with lowering soil toxicity by extracting volatile organics (specifically chlorinated organics) results in effective treatment for a wide range of organic compounds. The off-gas from the vacuum extraction system would be treated by using vapor phase activated carbon. The carbon is periodically changed out and treated to destroy retained organics.

The estimated time for implementation is 18 months at a capital cost of \$1,070,000.

Soils Incineration

This alternative consists of excavation and treatment of site soils using a rotating, refractory lined kiln with a capacity of 20 tons per hour. Organic constituents in the soils would be destroyed with an efficiency no less than 99.99%. Off-gas treatment would meet RCRA incinerator standards. Treated soils would be tested and, if necessary, stabilized before on-site backfilling.

The estimated time for implementation is 190 days excluding mobilization start-up, testing, demobilization and decontamination. The total time for implementation is estimated at 1 year.

The capital costs are \$28,260,000.

Thermal Desorption

This alternative consists of excavation and treatment of soils by thermal desorption of organics using a rotating kiln with soil lifters and a capacity of 40 tons per hour. The organics are desorbed from the soil and entrained in the gas stream. The off-gas is treated with vapor phase activated carbon to remove the organics prior to atmospheric discharge. The carbon is periodically changed out and treated to destroy retained organics. Treated soil would be tested and, if necessary, stabilized before on-site backfilling.

The estimated time for implementation is 95 days excluding mobilization, start-up, testing, demobilization and decontamination. The total time for implementation is estimated to be less than 1 year. The capital costs are \$18,250,000.

Soil Excavation and Off-site Disposal

This alternative consists of excavating the site soils that are above the target cleanup levels and transporting the excavated soils to an off-site RCRA landfill for disposal. The Land Disposal Restrictions go into effect for CERCLA soils in November 1990. Soil pretreatment (e.g., solidification/fixation/aeration) may become necessary for this alternative. The

excavated area would be backfilled with clean material. A one foot layer of topsoil would be installed.

The time for implementation for this alternative is estimated to be 120 days at a capital cost of \$20,700,000.

Soil Excavation and Off-site Thermal Treatment

This alternative consists of excavating the site soils that are above the target cleanup levels and transporting the excavated soils to an off-site RCRA incinerator for treatment and disposal.

Excavated areas would be backfilled with clean material. A one foot layer of top soil would be installed.

The time for implementation for this alternative is estimated to be 120 days at a capital cost of \$100,000,000.

SUMMARY OF ASSEMBLED ALTERNATIVE ANALYSIS

Each assembled alternative is evaluated using technical and environmental criteria and cost estimates. For the technical analysis, each alternative is evaluated on effectiveness and implementability. For the environmental analysis, each alternative is evaluated for compliance with federal and state environmental laws and regulations, protection of human health and environment, and effects of institutional parameters. The detailed cost analysis for each alternative includes estimates of operation and maintenance (O&M) costs, capital costs, replacement costs, and development of present worth. The present worth includes the initial construction costs and the

present worth of O&M costs and replacement costs. Since the technical approach and technologies used in development and comparison of assembled alternatives involve some assumptions, the assumed technology or design features may differ from those found in the final design.

All retained alternatives with the exception of No Action were determined to be technically effective and implementable, to meet or exceed ARARs, and to provide comparable protection of human health and the environment.

State and Community Acceptance of the selected remedial alternative will be assessed by the U.S. EPA.

A summary of each alternative to the seven evaluation criteria is provided below:

No Action

This alternative is implementable and with institutional controls would mitigate potential impacts to public health and the environment. Compliance with chemical specific ARARs would not be achieved.

Ground Water Extraction and Liquid Phase Carbon Adsorption

This alternative meets the remedial action objectives, the technical feasibility criteria, meets or exceeds ARARs and provides long-term and short-term protection of human health and the environment.

Ground Water Extraction and Air Stripping With Off-gas Control by Vapor Phase Carbon Adsorption

This alternative meets the remedial action objectives, the technical feasibility criteria, meets or exceeds ARARs and provides long-term and short-term protection of human health and the environment.

Effluent Discharge Alternatives

The effluent discharge alternatives meet technical feasibility requirements and achieve protection of public health and the environment. Compliance with ARARs will be determined during design, contingent upon the alternative selected and potential wetlands impact.

In-situ Soil Venting

This alternative meets the remedial action objectives for soil treatment, meets the technical feasibility criteria, meets or exceeds ARARs and provides long-term and short-term protection of human health and the environment.

This alternative also meets the preference for on-site treatment.

Soil Excavation and Incineration

This alternative meets the remedial action objectives for soil treatment, meets the technical feasibility criteria, meets or exceeds ARARs and provides long-term and short-term protection of human health and the environment.

This alternative meets the preference for on-site treatment.

Soil Excavation and Thermal Desorption

This alternative meets the remedial action objectives for soil treatment, meets the technical feasibility criteria, meets or exceeds ARARs and provides long-term and short-term protection of human health and the environment.

This alternative meets the preference for on-site treatment.

Soil Excavation and Off-site Disposal

This alternative meets the remedial action objectives for soil treatment, meets the technical feasibility criteria, meets or exceeds ARARs and provides long-term and short-term protection of human health and the environment.

This alternative does not meet the preference for on-site treatment.

Soil Excavation and Off-site Thermal Treatment

This alternative meets the remedial action objectives for soil treatment, meets the technical feasibility criteria, meets or exceeds ARARs and provides long-term and short-term protection of human health and the environment.

This alternative does not meet the preference for on-site treatment.

EVALUATION CRITERIA SUMMARY

Each of the assembled alternatives with the exception of no

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action are protective of human health and the environment, attain ARARs, utilize permanent solutions and comply with the statutory preference for treatment.

**SECTION 1.0
INTRODUCTION**

This Draft Feasibility Study (FS) report for the South Carolina Recycling and Disposal Inc. (SCRDI) Bluff Road Site has been prepared by contractors for the Bluff Road Group on behalf of the Bluff Road Group. The Group consists of some of the companies designated as potentially responsible parties (PRPs). This report has been prepared in accordance with the following documents and is submitted to the U.S. Environmental Protection Agency (EPA) for review and approval:

- o National Oil and Hazardous Substances Pollution Contingency Plan (NCP) 40 CFR Section 300.68(g), 50 FR 47912, 47974 (November 20, 1985)
- o EPA's "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA" Interim Final, October 1988
- o EPA's "Guidance on Remedial Actions for Contaminated Ground Water at Superfund Sites," December 1988
- o The Superfund Amendments and Reauthorization Act of 1986 (SARA)

1.1 PURPOSE AND ORGANIZATION OF REPORT

The purpose of this document is to summarize the screening methodology and develop considerations leading to a recommendation by EPA for an appropriate remedial alternative needed to prevent or mitigate the release or threatened release of contaminants from the SCRDI Bluff Road site.

The FS develops an appropriate range of waste management options, screens the various alternative technologies developed, and analyzes the effectiveness of those options against evaluation and analysis of selected criteria. The FS gives a conceptual overview of remedial alternatives but it is not intended to present design level detail.

The FS presented here follows the suggested format from the EPA Guidance.

Section 2	Remedial Action Objectives
Section 3	Cleanup Goals and ARARs
Section 4	Development and Initial Screening
Section 5	Detailed Analysis

1.2 SITE BACKGROUND

1.2.1 Site Description

The Bluff Road site is located in Richland County, South Carolina (Figure 1-1) and is approximately 10 miles south of the City of Columbia on the north side of State Highway 48 (Figure 1-2). The site is a rectangular parcel of land measuring 133 feet of frontage on Bluff Road (Highway 48), with a depth of approximately 1,300 feet. The site is relatively level with ground elevations varying from approximately 139 feet [United States Geological Survey (USGS) datum] near the highway to 134 feet at the rear of the property. The front portion of the site, approximately 600 feet from the road, is cleared and has been used for various industrial and commercial purposes. The back portion of the site, encompassing one half of the area, is heavily wooded (Figure 1-3).

1.2.2 Site History

The first reported use of the site was as an acetylene gas manufacturing facility. Specific dates and other details regarding the facility operations are not available. However, two lagoons were constructed at the north end of the cleared area of the site to support acetylene manufacturing.

In 1975, the site became a marshalling center for Columbia Organic Chemicals. Columbia Organic Chemicals funded the

operations of Bluff Road which used the site beginning in 1976 to store, recycle, and dispose of chemical wastes. The site was closed in 1982 after a ground water investigation conducted by the South Carolina Department of Health and Environmental Control (SCDHEC) and EPA revealed the presence of site contamination of soils and ground water.

A surficial cleanup of the site was performed in 1982 and 1983. Over 7,500 drums containing various chemicals were removed from the site for disposal. Visibly contaminated soil and all aboveground structures were also removed from the site. Clean fill and gravel were placed on the site to fill in excavations and provide clean roads. The two lagoons and an aboveground tank containing approximately 100 gallons of sludge were left on site.

1.2.3 Previous Investigations

- o Site Investigations Performed by EPA Region IV and SCDHEC

The first investigation conducted on the site was performed by the Surveillance and Analysis Division of EPA. Results are described in EPA's report, "Ground Water and Surface Water Investigation, South Carolina Recycling and Disposal, Inc., Bluff Road Site, Columbia, South Carolina," July 1, 1980.

Ground water conditions at the site were investigated by SCDHEC and described in its report, "Investigation of Ground Water at South Carolina Recycling and Disposal Company, Bluff Road Site, Richland County, South Carolina," January 1981. Ground water sampling was again performed by SCDHEC in August 1982 and the results published as an addendum to the 1981 report.

- o Golder's RI

Golder Associates (contracted to SCDHEC) began an RI of the site and adjacent affected properties in 1985 and 1986. This RI was never completed. Results of the RI are described in Golder's second draft report

entitled "Remedial Investigation, Bluff Road Site, Richland County, South Carolina," April 1986.

o Site Radiological Survey

SCDHEC's Bureau of Solid and Hazardous Waste (BSHW) and the South Carolina Bureau of Radiation Protection (BRP) conducted a radiological survey of the site in February 1988. The survey revealed no gamma radiation readings above background levels.

1.3 REMEDIAL INVESTIGATION SUMMARY

1.3.1 Residential Well Survey

In January 1989, ESRI (University of South Carolina) conducted a residential well survey within a 1-mile radius of the site. The purpose of the survey was to identify the number and type of ground water well users.

Four domestic (Class 1) water wells and one agriculture (Class 3) well were identified within the area of interest 1 mile downgradient of the Bluff Road Site. No industrial (Class 2) wells were located.

1.3.2 Meteorology

The climate of the region is classified as humid-subtropical, characterized by long hot summers, relatively short mild winters, and high humidity most of the year. Detailed meteorological data is provided in Section 3.2 of the RI.

1.3.3 Surface Water Hydrology

The soil in the region of the Bluff Road Site is characterized by a surface layer rich in silt and clay that causes water to pond instead of infiltrate. Drainage off the study area is away from the topographic high at Bluff Road (State Highway 48) and to the east. Bluff Road, however, runs along a drainage divide so that most of the drainage on the southwest side of the road is to the west. Drainage is into Myers Creek

about 3,200 feet east of the site.

1.3.4 Regional Geology

The regional stratigraphy of the study area is divided into three major units. Pre-Mesozoic crystalline bedrock (Unit 1) is probably fractured and deeply weathered. The upper surface of this basement is irregular, with relief similar to the overlying sedimentary deposits. The basement surface dips toward the southeast with a gradient of about 20 to 40 feet per mile.

Coastal Plain sediments overlie the crystalline bedrock (Table 1-1). The Upper Cretaceous Middendorf/Black Creek Unit (Unit 2) is the oldest Coastal Plain sedimentary formation in the subsurface in southern Richland County. This unit extends southward beneath the entire South Carolina Coastal Plain, thickening and becoming more marine to the southeast. It is the principal aquifer in the South Carolina Coastal Plain (Colquhoun et al., 1969).

The Middendorf, also locally referred to as the Tuscaloosa Formation, is a complex assortment of lithologies. It contains variegated (generally light) fine- to coarse-grained quartzose, feldspacktic sands, and light colored clays containing variable amounts of silt and sand. Fine- to medium-grained gravel, mica, and lignitic wood fragments are common constituents of this formation.

Above the Middendorf lies the Black Creek Formation. In the region of the Bluff Road Site, it is approximately 100 feet thick. It consists mostly of fine-grained sediments such as clays and silts; locally, lenses of coarser grained sand are present. The clays are typically dark brown, micaceous, highly plastic, and carbonaceous.

The Middendorf and Black Creek Formations are the most important hydrogeologic strata in the sedimentary prism of the Coastal Plain. Younger deposits rest uncomfortably on these older units across much of the Coastal Plain. The younger strata include Plio-Pleistocene terrace deposits of the middle Coastal Plain and the Holocene sediments of the floodplains.

The third major unit in the study area is the Plio-Pleistocene Okefenokee terrace deposits. These sediments are readily seen in the vicinity of the site wherever sand and clay beds are exposed in drainage ditches and road cuts. The sediments of the Okefenokee terrace are variable in thickness, but in this locality they are between 20 and 40 feet thick. The sediments are probably not marine in character but conform with the marine shoreline, as do the sediments of the other local terrace formations.

The Okefenokee terrace sediments contain various admixtures of silts, clays, and sands in beds that thicken or thin appreciably within short distances. The lithology of one bed commonly grades laterally or vertically into another lithology, for example, from sand to sandy clay. Thus, even within a site-specific area of only a few hundred square feet, it is not unusual to find that the subsurface geology of these sediments is difficult to correlate from one borehole to another. This is typical of terrace deposits.

West-southwest of the site, the top of the crystalline bedrock lies about 100 to 150 feet below mean sea level, the sedimentary section at the site is estimated to be about 240 to 290 feet thick, depending on land surface elevation at any particular point.

1.3.5 Soils

The soils identified in the project by the Richland County Soil Survey include loams, which are mixtures of sand, silt, and clay. The specific soil types present in the vicinity of the site are Orangeburg loamy sand, Persanti very fine sandy loams, Smithboro Loam, and Cantry loam.

1.3.6 Hydrogeology

1.3.6.1 Regional Hydrogeology

The stratigraphy of the study area may be divided into four hydrologically connected water-bearing units underlying the Bluff Road Site (Aucott and Speiran, 1985). Hydrogeologic units are as follows:

- o A shallow, surficial aquifer in the Okefenokee terrace, underlain by a clay or sandy clay aquitard, part of the Black Creek Formation
- o A deep aquifer consisting of sand and clay, also part of the Black Creek Formation, underlain by another aquitard of sandy clay
- o The deepest aquifer, the Middendorf Formation, consisting of sand, silt, and clay (which many geologists call the Tuscaloosa Aquifer, Colquhoun et al., 1969)
- o The crystalline pre-Mesozoic basement which has virtually no primary porosity but possibly has significant high secondary fracture porosity.

1.3.6.2 Local Hydrogeology of the Shallow Aquifer

The shallow aquifer typically extends to a depth of 45 to 50 feet and is composed primarily of sands which range from coarse and well sorted to silty and poorly sorted. It is semiconfined by a resistant layer composed of varying amounts of clay, silt, and sand which usually lies from the surface to depth ranging from 5 to 15 feet.

The ground water table in the shallow aquifer generally lies 10 to 15 feet below ground surface based on the three rounds of ground water level measurements taken.

Contour maps of the ground water surface of the shallow aquifer are presented for May 24, 1989 (Figure 1-4) and for June 1, 1989 (Figure 1-5). Both figures indicate that the overall ground water flow is approximately to the east. The gradient of the potentiometric surface is about 0.003 near Bluff Road and flattens dramatically to less than 0.001 in the vicinity of MW-4, MW-6, MW-8, and MW-12. The surface in this area is very irregular and flow patterns are subject to local influences. Overall discharge may be to Myers Creek.

1.3.6.3 Local Hydrogeology of the Deep Aquifer

Within the area encompassed by well installation, the deep aquifer is separated from the shallow aquifer by a clay and silt unit which ranges in thickness from 1.5 to 25 feet. This partial confining layer is thinnest upgradient of the site in the vicinity of MW-6 and MW-7 and thickens to the south and west. The lithology of the deep aquifer is similar to that of the shallow aquifer, though clay-rich layers are more common. Both the clay aquitard and the deep aquifer are thought to be units in the Black Creek Formation.

The ground water contour maps of the deep aquifer are presented for measurements taken on May 24, 1989 (Figure 1-6) and June 1, 1989 (Figure 1-7). Both maps were contoured using water level data from the four wells installed by IT. The gradient of the potentiometric surface in the deep aquifer is 0.0003 ft/ft toward the south.

1.4 NATURE AND EXTENT OF CONTAMINATION

In 1989, a remedial investigation (RI) involving sampling of the soil, surface waters, sediments, ground water, and air was conducted at the SCRDI site to define the characteristics and extent of contamination at the site. Comparison of the detected levels of specific compounds to developed target cleanup criteria is presented in Section 3.0.

1.4.1 Ground Water

1.4.1.1 Surficial Aquifer

Nineteen monitoring wells were installed in the surficial aquifer to define the extent and characteristics of ground water contamination. The analytical results defined a contaminant plume approximately 1000 feet wide extending approximately 2200 feet southeast of the site (see Figures 1-8, 1-8a and 1-8b.) The depth of the surficial aquifer is approximately 40 feet. Based on a medium sand porosity of 0.4, the estimated volume of the plume is 263,296,000 gallons. The primary components of the contamination are volatile organic compounds. The detected volatile and semi-volatile compounds, highest concentrations detected and frequency of detection are summarized in Table 1-2. Trace levels of semi-volatile compounds were detected in three wells. Detected metals, highest concentration and frequency of detection are summarized in Table 1-3.

1.4.1.2 Deep Aquifer

Four monitoring wells were installed in the upper portion of the deep aquifer regionally downgradient of the site. These wells were completed below a clay aquitard found at 41 of 41 locations over the area encompassed by well installation. Analytical results for samples of these four lower aquifer wells showed no contamination, indicating the deep aquifer has

not been impacted by contamination detected in the surficial aquifer.

1.4.2 Soils

The RI investigated surface and subsurface soils as potential source areas contributing volatile organics to the surficial aquifer. Dry lagoon sediments identified in the RI are included as soils for this and subsequent evaluations. Wet lagoon sediments are addressed in Section 1.4.3.1.

1.4.2.1 Surface Soils

Forty-two surface soil samples were taken on and off the site in areas of known or suspected contamination. Sampling locations and the areas of significant organic compound content are shown on Figure 1-9. The areas associated with volatile and semi-volatile detection are approximately the same. Tables 1-4 and 1-5 summarize the detected compounds, location of the highest concentration detected and the frequency of detection for volatile compounds and semi-volatile compounds respectively.

Two general areas of surface soil contamination were identified. The most significant area of surface soil contamination is found on the southwestern edge of the SCRDI property in the vicinity of SS4 and SS5. This area encompasses approximately 350 X 200 feet (70,000 sq ft). A second area of surface soil contamination was identified in the central portion of the SCRDI property (the dry lagoon area) at lower concentrations than those seen at the southwestern edge of the property. This second area encompasses approximately 100 X 100 feet (10,000 sq ft).

Low levels of pesticides/PCBs were also detected in the area

of SS-4 and SS-5. Compounds detected, the location of the highest concentration detected and frequency of detection are summarized in Table 1-6.

A summary of metals detected, the location of the highest concentration detected and frequency of detection is provided in Table 1-7. One sample out of thirty-four (SS-5) had a concentration of cadmium above the established background range. Two samples out of thirty-four (SS-4 and SS-5) had concentrations of mercury above the background range. The levels detected and the localized area indicate that metals in the surface soil are not of concern.

1.4.2.2 Subsurface Soils

Twenty-nine soil borings were taken on and off the site. Samples were taken at 3 to 7 and 7 to 11 foot intervals at each location. One additional sample at 11 to 15 feet was taken at B9. Figure 1-10 shows the sampling locations and areas of significant volatile compound content. The volatile compounds detected, the location of the highest concentration detected and depth, second highest concentration location and depth, and frequency of detection are summarized in Table 1-8. The highest concentrations were generally limited to the upper 7 feet of the unconsolidated zone with concentrations generally decreasing with depth; however, elevated levels were detected from the surface to the water table. The areas of detected elevated levels are limited to the proximity of B4 and B5 with lower levels seen in the area of B8 and B9 (approximately 300 feet ENE of B4/B5). This encompasses an area of approximately 400 feet X 250 feet (112,500 sq ft) that essentially overlaps that area identified with elevated volatile concentrations in surface soils. Concentrations generally decreased with depth.

Semi-volatile compounds were also detected in the same limited areas of B4/B5 and B8/B9. The highest concentrations were generally limited to the upper 7 ft of the unconsolidated zone with concentrations decreasing with depth; however, elevated levels were detected from the surface to the water table. Semi-volatile compounds detected, the location of the highest concentration and depth, second highest location and depth, and frequency of detection are summarized in Table 1-9.

Low levels of pesticides/PCBs were detected in the subsurface soils in the B5, B8/B9 area, limited to the upper 7 ft of the unconsolidated zone. Table 1-11 summarizes the compounds detected, the location of the highest concentration detected and frequency of detection. One sample (B13) showed a level of selenium above the expected background range.

A summary of metals detected, the location of the highest concentration detected and frequency of detection is provided in Table 1-10. One boring out of the twenty-nine taken (B13) has a concentration of selenium above the established background range. The levels detected and the localized area indicate that metals in the surface soil are not of concern.

1.4.3 Other Media

1.4.3.1 On-site Surface Water and Surface Water Sediment

The wet lagoon water and sediment samples indicated trace volatile and semi-volatile constituents. Sediment metals concentrations were within expected background ranges with the exception of calcium. Summaries for compounds detected and frequencies are provided in Tables 1-12, 1-13 and 1-14.

1.4.3.2 Off-Site Surface Water and Surface Water Sediment

Samples of off-site surface water and surface water sediment indicated no site related contamination. One sample (RS2) showed an elevated level of the naturally occurring compound benzoic acid. This was determined in the RI not to be site related.

1.4.3.3 Ambient Air

Ambient air samples were collected on the SCRDI property. Toluene was detected in two of three bag samples at 22 and 27 ppb. No other constituents were detected.

1.4.4 Summary

Elevated levels of site-related compounds at the SCRDI site are limited to the on-site soils and the shallow ground water aquifer.

The shallow aquifer plume encompasses an area of approximately 1000 feet by 2200 feet over the depth of the surficial aquifer of 40 feet. This correlates to an approximate volume of 263,396,000 gallons.

Localized areas of soil contamination provide the potential for continuing sources for degradation of the ground water. The estimated volume of impacted soils is approximately 45,370 cubic yards, based on approximately 10 feet of unconsolidated material above the true surficial aquifer water table and the areas identified in Sections 1.4.2.1 (10,000 sq ft in dry lagoon area) and 1.4.2.2 (112,500 sq ft that overlaps surficial soil area). Based on current data, this is considered a conservative estimate. Figure 1-11 depicts the area identified for potential soil remediation. The actual range is expected to be 28,000 to 45,000 cubic yards. Should soil treatment be deemed necessary, confirmatory work would

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have to be performed during remedial design to develop a detailed design basis for any soil remediation activity.

Table 1-1
Generalized Geohydrologic Units

Aquifer	System	Formation	Description
Surficial	Quaternary	Coastal terrace	Reddish brown, orange, gray, and white sand deposits and clay
Floridan aquifer system (down-dip)	Tertiary	Cooper group (lower part)	Green or brown, grayish sandy phosphatic, fossiliferous limestone, and marl
		Ocala limestone	White to cream colored, calcitized, fossiliferous limestone
		Santee limestone	White to creamy yellow, fossiliferous, glauconitic limestone with numerous bryozoans, interlayered in part with gray to yellow sandstone
Tertiary sand (up-dip)	Tertiary	Barnwell formation	Fine to coarse, red to brown massive sand
		McBean formation	Fine, green to yellow, glauconitic sand and gray-green glauconitic marl
		Congaree formation	Yellowish-brown to green, fine to coarse, glauconitic quartz sand or sandstone interbedded with dark green to gray clays
		Blank Mingo formation (upper-part)	Gray sand shale and black sand limestone; may be carbonaceous and fossiliferous in places

Table 1-1 (Continued)
Generalized Geohydrologic Units

Aquifer	System	Formation	Description
Black Creek	Cretaceous	Black Creek formation	Gray to white, glauconitic, phosphatic, micaceous calcareous quartz sand interbedded with dark gray to black, thinly laminated clay containing nodules of pyrite and marcasite and fragments of lignite
Middendorf	Cretaceous	Middendorf formation	Light gray, fine to coarse, micaceous, glauconitic and, in part, calcareous sand interbedded with green, purple, and maroon clay and greenish-gray micaceous silt, sandstone and grit
Cape Fear	Cretaceous	Cape Fear formation	Reddish-brown, gray, and greenish clay interbedded with yellow to white, fine to coarse quartz and feldspar sand with some mica

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TABLE 1-
GROUNDWATER SUMMARY
ORGANICS

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<u>COMPOUND</u>	<u>HIGH CONC.</u> <u>PPB</u>	<u>LOW CONC.</u> <u>PPB</u>	<u>HIGH</u> <u>LOCATION</u>	<u>NO. OF DETECTIONS/</u> <u>NO. OF SAMPLES</u>	<u>BLANK</u> <u>CONTAMINATION</u>
VOLATILES					
Carbon Tetrachloride	200	ND	13B	7/23	NO
Acetone	18000	2	2A	23/23	YES
Chloroform	2000	ND	4B	10/23	NO
Benzene	110	ND	2A	2/23	NO
1,1,1-Trichloroethane	260	ND	13B	6/23	NO
Methylene Chloride	35	ND	4A	7/23	YES
Carbon Disulfide	4	ND	1A	1/23	NO
1,1-Dichloroethane	2000	ND	2A	6/23	NO
1,1-Dichloroethene	1200	ND	2A	7/23	NO
1,2-Dichloropropane	21	ND	2A	3/23	NO
2-Butanone	2100	ND	2A	1/23	NO
1,1,2-Trichloroethane	9	ND	2A	3/23	NO
Trichlorethene	220	ND	4A	6/23	NO
1,1,2,2-Tetrachloroethane	440	ND	4A	6/23	NO
Ethylbenzene	220	ND	2A	2/23	NO
1,2-Dichloroethane	280	ND	2A	3/23	NO
4-Methyl-2-Pentanone	98	ND	2A	1/23	NO
Toluene	980	ND	2A	2/23	NO
Chlorobenzene	16	ND	2A	1/23	NO
Tetrachlorethene	68	ND	13B	7/23	NO
1,2-Dichloroethene	6800	ND	2A	5/23	NO
Total Xylenes	360	ND	2A	2/23	NO
SEMI-VOLATILES					
Dicthylphthalate	2	ND	7C	1/23	NO
N-Nitrosodiphenylamine	4	ND	7B	1/23	NO
1,2-Dichlorobenzene	4	ND	4A	1/23	NO

TABL
GROUNDWATER SUMMARY
METALS

<u>COMPOUND</u>	<u>HIGH CONC.</u> <u>PPB</u>	<u>LOW CONC.</u> <u>PPB</u>	<u>HIGH</u> <u>LOCATION</u>	<u>NO. OF DETECTIONS/</u> <u>NO. OF SAMPLES</u>	<u>BLANK</u> <u>CONTAMINATION</u>
Aluminum	310	ND	2B	22/23	NO
Iron	156	0.06	2A	23/23	NO
Magnesium	15.6	0.336	2A	23/23	NO
Manganese	3.04	0.011	2A	23/23	NO
Nickel	0.185	ND	2B	23/23	NO
Potassium	7.41	ND	2A	16/23	NO
Sodium	37.5	ND	2A	22/23	NO
Barium	3.27	0.01	2B	23/23	NO
Beryllium	0.066	ND	2B	9/23	NO
Cadmium	0.037	ND	7C	6/23	NO
Chromium	0.315	ND	2B	10/23	NO
Cobalt	0.154	ND	10B	9/23	NO
Copper	0.411	ND	2B	17/23	NO
Vanadium	0.833	ND	2B	9/23	NO
Zinc	0.551	0.009	2B	23/23	NO
Calcium	84.5	1.81	11A	23/23	NO
Lead	0.257	ND	2B	13/23	NO
Arsenic	0.004	ND	7C	1/23	NO
Selenium	0.003	ND	7C	2/23	NO
Mercury	0.0009	ND	2B	6/23	NO

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TABLE 1-4
SURFACE SOIL SUMMARY
VOLATILES

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<u>COMPOUND</u>	<u>HIGH CONC.</u> <u>PPB</u>	<u>LOW CONC.</u> <u>PPB</u>	<u>HIGH</u> <u>LOCATION</u>	<u>NO. OF DETECTIONS/</u> <u>NO. OF SAMPLES</u>	<u>BLANK</u> <u>CONTAMINATION</u>
Acetone	45,000	6	SS4	42/42	YES
Chloroform	10,000	ND	SS5	3/42	NO
1,1,1,-Trichloroethane	14,000	ND	SS5	4/42	NO
Methylene Chloride	4,700	ND	DLS2	41/42	YES
Carbon Disulfide	1	ND	SS14	1/42	NO
1,1-Dichloroethane	390	ND	SS5	2/42	NO
2-Butanone	55	ND	SS3	3/42	NO
Trichloroethene	44,000	ND	SS5	8/42	NO
1,1,2,2-Tetrachloroethane	100,000	ND	SS4	1/42	NO
Ethylbenzene	710	ND	SS5	3/42	NO
4-Methyl-2-Pentanone	3	ND	SS3	1/42	NO
Toluene	29,000	ND	SS4	16/42	YES
Chlorobenzene	16,000	ND	SS4	1/42	NO
Tetrachloroethene	56,000	ND	SS4	8/42	NO
1,2-Dichloroethene	45	ND	SS3	2/42	NO
Total Xylenes	5,200	ND	SS4	4/42	NO
Styrene	6	ND	SS38	1/42	NO
Vinyl Chloride	24	ND	DLS1	1/42	NO
1,1-Dichloroethene	240	ND	DLS3	2/42	NO
Benzene	590	ND	DLS2	2/42	NO
1,2-Dichloroethane	120	ND	DLS1	1/42	NO

TABLE
SURFACE SOIL SUMMARY
SEMI-VOLATILES

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<u>COMPOUND</u>	<u>HIGH CONC.</u> <u>PPB</u>	<u>LOW CONC.</u> <u>PPB</u>	<u>HIGH</u> <u>LOCATION</u>	<u>NO. OF DETECTIONS/</u> <u>NO. OF SAMPLES</u>	<u>BLANK</u> <u>CONTAMINATION</u>
Benzoic Acid	3,800	ND	SS38	19/42	NO
Di-n-butylphthalate	2,200	ND	SS4	8/42	NO
Naphthalene	1,200	ND	SS4	1/42	NO
2-Methylphenol	58,000	ND	SS4	1/42	NO
2-Chlorophenol	200,000	ND	SS4	2/42	NO
2,4,5-Trichlorophenol	810	ND	SS4	1/42	NO
Benzyl Alcohol	110,000	ND	SS4	1/42	NO
4-Methyl Phenol	14,000	ND	SS4	3/42	NO
Phenol	210,000	ND	SS5	31/42	NO
Bis(2-Ethylhexyl) Phthalate	7,600	ND	SS5	41/42	YES
Di-n-octylphthalate	44,000	ND	SS4	5/42	NO
Hexachlorobenzene	7,200	ND	SS4	3/42	NO
Isophorone	450	ND	SS4	1/42	NO
2,4-Dichlorophenol	29,000	ND	SS4	1/42	NO
Diethylphthalate	1,500	ND	SS4	1/42	NO
N-Nitrosodiphenylamine	50	ND	SS21	1/42	NO

TABLE 1-6
SURFACE SOIL SUMMARY
PESTICIDES/PCB'S

<u>COMPOUND</u>	<u>HIGH CONC.</u> <u>PPB</u>	<u>LOW CONC.</u> <u>PPB</u>	<u>HIGH</u> <u>LOCATION</u>	<u>NO. OF DETECTIONS/</u> <u>NO. OF SAMPLES</u>	<u>BLANK</u> <u>CONTAMINATION</u>
4,4'-DDE	85	ND	SS5	3/42	NO
4,4'-DDD	46	ND	SS19	1/42	NO
4,4'-DDT	220	ND	SS4	4/42	NO
Methoxychlor	2700	ND	SS4	3/42	NO
Dieldrin	52	ND	SS20	1/42	NO
Endosulfan II	26	ND	SS20	1/42	NO
Arochlor 1242	1900	ND	SS5	2/42	NO
Endosulfan Sulfate	600	ND	DLS3	1/42	NO

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TABLE 1-7
SURFACE SOIL SUMMARY
METALS

COMPOUND	HIGH CONC.	LOW CONC.	HIGH LOCATION	NO. OF DETECTIONS NO. OF LOCATIONS	BLANK CONTAMINATION	ESTIMATED BACKGROUND CONCENTRATION		NO. OF LOCATIONS ABOVE BACKGROUND RANGE
	PPM	PPM				RANGE	AVERAGE PPM	
Aluminum	13,500	1170	SS18	34/34	NO	7000-100,000 ^a	33,000	0
Iron	39,000	1310	SS11	34/34	NO	100-100,000 ^a	14,000	0
Magnesium	813	16	SS4	34/34	NO	50-50,000 ^a	2,100	0
Manganese	1,240	2.5	SS21	34/34	NO	2-7,000 ^a	250	0
Nickel	34	ND	SS5	11/34	NO	5-700 ^a	11	0
Potassium	2,690	ND	SS4	8/34	NO	50-37,000 ^a	12,000	0
Silver	5	ND	SS18	5/34	NO	.01-5 ^b	0.05 ^b	0
Sodium	346	ND	SS5	23/34	NO	500-50,000 ^a	2,500	0
Antimony	6	ND	SS18	2/34	NO	<1-8.8 ^a	0.52	0
Barium	190	18	SS1	34/34	NO	10-1500 ^a	290	0
Beryllium	1.3	ND	SS18	32/34	NO	<1-7 ^a	0.55	0
Cadmium	4	ND	SS5	5/34	NO	<0.2-1 ^b	0.5 ^b	1
Chromium	64	2	SS4	34/34	NO	1-1000 ^a	33	0
Cobalt	9	ND	SS5	16/34	NO	<0.3-70 ^a	5.9	0
Copper	205	ND	SS5	32/34	NO	<1-700 ^a	13	0
Vanadium	64	4	SS11	34/34	NO	<7-300 ^a	43	0
Zinc	738	3	SS5	32/34	NO	<5-2900 ^a	40	0
Calcium	94,800	86	SS24	34/34	no	100-280,000	3,400	0
Lead	158	7	SS5	34/34	NO	<10-300 ^a	14	0
Arsenic	8.2	ND	SS5	15/34	NO	<0.1-73 ^a	4.8	0
Selenium	3.6	ND	SS20	3/34	NO	<0.1-3.9 ^a	0.3	0
Mercury	6.56	ND	SS5	29/34	NO	0.01-3.4 ^a	0.081	2
Thallium	0.9	ND	SS17	7/34	NO	2.2-23	7.7	0

^a USGS Paper 1270 (1984).

^b Office of Toxic Substances, USEPA (1984)

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TABLE 1-8
SOIL BORING SUMMARY
VOLATILES

COMPOUND	HIGH CONC. PPB	AVE ACROSS HIGH BORING	HIGH LOCATION	HIGH DEPTH FT	SECOND HIGH CONC. PPB	SECOND HIGH LOCATION	SECOND HIGH DEPTH	NO. OF DETECTIONS/ NO. OF LOCATIONS	BLANK CONTAMINATION
Carbon Tetrachloride	4,100*	2,050	B5	3-7	0	N/A	N/A	1/29	NO
Acetone	160,000*	92,000	B5	3-7	5400	B7	3-7	29/29	YES
Chloroform	160	81.5	B8	3-7	51	B9	7-11	4/29	NO
Benzene	7	2.3	B9	7-11	3	B8	3-7	2/29	NO
1,1,1-Trichloroethane	6,800*	3,400	B5	3-7	220	B9	7-11	3/29	NO
Methylene Chloride	39,000*	22,750	B5	3-7	140	B9	7-11	29/29	YES
Carbon Disulfide	2	1	B13	7-11	2	B15	7-11	2/29	NO
1,1-Dichloroethane	69	23	B9	7-11	3	B13	7-11	5/29	NO
1,1-Dichloroethene	44	27.7	B9	11-15	4	B13	7-11	2/29	NO
2-Butanone	89,000*	51,500	B5	3-7	1400	B4	3-7	13/29	NO
1,1,2-Trichloroethane	7	2.3	B9	7-11	0	N/A	N/A	1/29	NO
Trichloroethene	25,000	12,500	B5	3-7	220	B9	7-11	3/29	NO
1,1,2,2-Tetrachloroethane	2,300,000	1,260,000	B5	3-7	1100	B9	3-7	9/29	NO
Ethylbenzene	18,000	9,000	B5	7-11	630	B9	3-7	5/29	NO
4-Methyl-2-Pentanone	340	186	B4	7-11	18	B9	11-15	4/29	NO
Toluene	340,000	174,800	B5	3-7	1000	B9	7-11	29/29	YES
Chlorobenzene	23,000*	11,500	B5	3-7	3	B8	3-7	2/29	NO
Tetrachlorethene	95,000	47,500	B5	3-7	940	B8	3-7	5/29	NO
1,2-Dichloroethylene	40	17.3	B9	7-11	0	N/A	N/A	1/29	NO
Total Xylenes	62,000	31,000	B5	3-7	3600	B9	7-11	11/29	NO

*Duplicate is significantly lower. Higher values used for this summary.

29 soil boring, samples at every location taken at 3-7'ft, 7-11'ft; at B-9 an additional sample at 11-15'ft was taken, total of 59 samples not including duplicates.

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TABLE 1-9
SOIL BORING SUMMARY
SEMI-VOLATILES

<u>COMPOUND</u>	<u>HIGH CONC. PPB</u>	<u>AVE ACROSS HIGH BORING</u>	<u>HIGH LOCATION</u>	<u>HIGH DEPTH FT</u>	<u>SECOND HIGH CONC. PPB</u>	<u>SECOND HIGH LOCATION</u>	<u>SECOND HIGH DEPTH</u>	<u>NO. OF DETECTIONS/ NO. OF LOCATIONS</u>	<u>BLANK</u>
Benzoic Acid	110,000	54,333	B9	3-7	5,400	B7	7-11	7/29	NO
Hexachloroethane	1200	600	B5	3-7	0	N/A	N/A	1/29	NO
Di-N-Butylphthalate	250	125	B8	3-7	92	B1	3-7	3/19	NO
N-Nitrosodiphenylamine	820	410	B5	3-7	260	B27	3-7	11/29	NO
2,4,6-Trichlorophenol	280	140	B5	3-7	0	N/A	N/A	1/29	NO
Naphthalene	3900	1,950	B5	3-7	0	N/A	N/A	1/29	NO
2-Methylphenol	120,000	65,500	B5	3-7	63	B4	7-11	2/29	NO
2-Chlorophenol	2,000,000	1,033,500	B5	3-7	290	B12	3-7	5/29	NO
2,4,5-Trichlorophenol	200	100	B5	3-7	0	N/A	N/A	1/29	NO
Nitrobenzene	11,000	5,685	B5	7-11	0	N/A	N/A	1/29	NO
Benzyl Alcohol	330,000	182,000	B5	3-7	230,000	B9	3-7	2/29	NO
4-Methylphenol	3,600	1,800	B5	3-7	260	B4	7-11	3/29	NO
Phenol	6,300,000	3,375,000	B5	3-7	1,800	B9	7-11	7/29	NO
Bis(2-Ethylhexyl) Phthalate	2,400	1,800	B8	3-7	1,900	B5	3-7	29/29	YES
Di-N-Octyl Phthalate	1,700	850	B8	3-7	650	B5	3-7	3/29	NO
Hexachlorobenzene	190	63.3	B9	7-11	0	N/A	N/A 1/29		NO
2,4-Dichlorophenol	130,000	65,000	B5	3-7	0	N/A	N/A	1/29	NO

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0051

TABLE 1-10
SOIL BORING SUMMARY
METALS

COMPOUND	HIGH CONC. PPB	HIGH LOCATIONS	NO. OF DETECTION/ NO. OF LOCATIONS	ESTIMATED BACKGROUND CONCENTRATION		NO. OF LOCATIONS ABOVE BACKGROUND RANGE
				RANGE PPM	AVERAGE PPM	
Aluminum	22,100	B25	29/29	7000-100,000 ^a	33,000	0
Iron	22,700	B7	29/29	100-100,000 ^a	14,000	0
Magnesium	816	B25	29/29	50-50,000 ^a	2,100	0
Manganese	211	B2	29/29	2-7,000 ^a	250	0
Nickel	8	B8	10/29	5-700 ^a	11	0
Potassium	663	B8	10/29	50-37,000 ^a	12,000	0
Silver	2.1	B14	3/29	0.01-5 ^b	0.05	0
Sodium	800	B28	26/29	500-50,000 ^a	2,500	0
Barium	103	B25	29/29	10-1500 ^a	290	0
Beryllium	1	B25	23/29	<1-7 ^a	0.55	0
Cadmium	0.7	B26	2/29	<0.2-1 ^b	0.50	0
Chromium	24	B25	29/29	1-1000 ^a	33	0
Cobalt	13	B25	8/29	1-1000 ^a	5.9	0
Copper	30	B7	29/29	0.3-70 ^a	13	0
Vanadium	42	B7	29/29	<1-700 ^a	43	0
Zinc	34	B8	29/29	<7-3400 ^a	40	0
Calcium	3,630	B15	29/29	<5-2900 ^a	3,400	0
Lead	28	B13	29/29	100-280,000 ^a	14	0
Arsenic	0.4	B4	1/29	<10-300 ^a	4.8	0
Thallium	0.4	B23	1/29	<0.1-73 ^a	7.7	0
Selenium	9.7	B13	5/29	<0.1-3.9 ^a	0.3	1
Mercury	0.37	B5	13/29	0.01-3.4 ^a	0.081	0

^a USGS Paper 1270 (1984).

^b Office of Toxic Substances, USEPA (1984).

4 9 0052

TABLE 1-11
SOIL BORING SUMMARY
PESTICIDES AND PCB'S

<u>COMPOUND</u>	<u>HIGH CONC.</u> <u>PPB</u>	<u>AVE ACROSS</u> <u>HIGH BORING</u>	<u>HIGH</u> <u>LOCATION</u>	<u>HIGH</u> <u>DEPTH FT</u>	<u>SECOND HIGH</u> <u>CONC. PPB</u>	<u>SECOND HIGH</u> <u>LOCATION</u>	<u>SECOND HIGH</u> <u>DEPTH</u>	<u>NO. OF DETECTIONS/</u> <u>NO. OF LOCATIONS</u>	<u>BLANK</u>
Lindane	12	6	B8	3-7	0	N/A	N/A	1/29	NO
Aroclor 1242	510	170	B9	3-7	260	B8	3-7	2/29	NO
Methoxychlor	160	80	B5	3-7	0	N/A	N/A	1/29	NO
Toxaphene	470	235	B5	3-7	0	N/A	N/A	1/29	NO
Heptachlor	86	43	B5	3-7	0	N/A	N/A	1/29	NO
Eldrin Ketone	47	23.5	B5	3-7	0	N/A	N/A	1/29	NO

4 9 0053

TABLE 1-12
WET LAGOON SEDIMENT SUMMARY
ORGANICS

4 9 0054

VOLATILES

<u>COMPOUND</u>	HIGH CONC. <u>CONC. PPB</u>	NO. OF DETECTIONS/ <u>LOCATIONS</u>	BLANK <u>CONTAMINATION</u>
Methylene Chloride	35	3/3	YES
Acetone	340	3/3	YES
Carbon Disulfide	10	2/3	NO
Toluene	5	2/3	NO

SEMI-VOLATILES

<u>COMPOUND</u>	HIGH CONC. <u>CONC. PPB</u>	NO. OF DETECTIONS <u>LOCATIONS</u>	BLANK <u>CONTAMINATION</u>
Bis(2-ethylhexyl) phthalate	1700	3/3	YES
Phenol	800	1/3	NO
Di-n-butylphalate	180	2/3	NO

PESTICIDES/PCBs

<u>COMPOUND</u>	HIGH CONC. <u>CONC. PPB</u>	NO. OF DETECTIONS <u>LOCATIONS</u>	BLANK <u>CONTAMINATION</u>
ND	ND	0/3	NO

TABLE . .3
WET LAGOON SEDIMENT SUMMARY
METALS

<u>COMPOUND</u>	<u>HIGH CONC. CONC. PPB</u>	<u>NO. OF DETECTIONS/ NO. OF SAMPLES</u>	<u>BLANK CONTAMINATION</u>
Aluminum	14,500	3/3	NO
Antimony	6	1/3	NO
Arsenic	1.6	1/3	NO
Barium	164	3/3	NO
Beryllium	0.8	3/3	NO
Calcium	443,000	3/3	NO
Chromium	42	3/3	NO
Copper	13	3/3	NO
Iron	7,710	3/3	NO
Lead	19	3/3	NO
Magnesium	494	3/3	NO
Manganese	108	3/3	NO
Mercury	0.62	2/3	NO
Nickel	13	1/3	NO
Sodium	428	3/3	NO
Vanadium	29	3/3	NO
Zinc	32	3/3	NO
Cyanide	13.2	1/3	NO

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0055

TABLE 4
WET LAGOON WATER SUMMARY

4 9 0056

VOLATILES

<u>COMPOUND</u>	HIGH CONC. <u>CONC. PPB</u>	NO. OF DETECTIONS/ <u>NO. OF SAMPLES</u>	BLANK <u>CONTAMINATION</u>
Methylene Chloride	2	3/3	YES
Acetone	1	1/3	YES
1,1-Dichloroethane	1	1/3	YES
1,1,1-Trichloroethane	1	1/3	NO
Tetrachloroethene	1	1/3	NO

SEMI-VOLATILES

<u>COMPOUND</u>	HIGH CONC. <u>CONC. PPB</u>	NO. OF DETECTIONS/ <u>NO. OF SAMPLES</u>	BLANK <u>CONTAMINATION</u>
Bis(2-ethylhexy) Phthalate	14	1/3	YES

PESTICIDES/PCB's

<u>COMPOUND</u>	HIGH CONC. <u>CONC. PPB</u>	NO. OF DETECTIONS/ <u>NO. OF SAMPLES</u>	BLANK <u>CONTAMINATION</u>
ND	ND	0/3	NO

METALS

<u>COMPOUND</u>	HIGH CONC. <u>CONC. PPB</u>	NO. OF LOCATIONS/ <u>NO. OF SAMPLES</u>	BLANK <u>CONTAMINATION</u>
Aluminum	0.16	2/3	NO
Arsenic	0.004	1/3	NO
Barium	0.038	3/3	NO
Calcium	72.5	3/3	NO
Iron	0.212	3/3	NO
Magnesium	1.34	3/3	NO
Manganese	0.027	3/3	NO
Mercury	0.0006	1/3	NO
Potassium	7.98	3/3	NO
Sodium	13.9	3/3	NO
Selenium	0.003	1/3	NO
Vanadium	0.011	2/3	NO
Zinc	0.012	3/3	NO

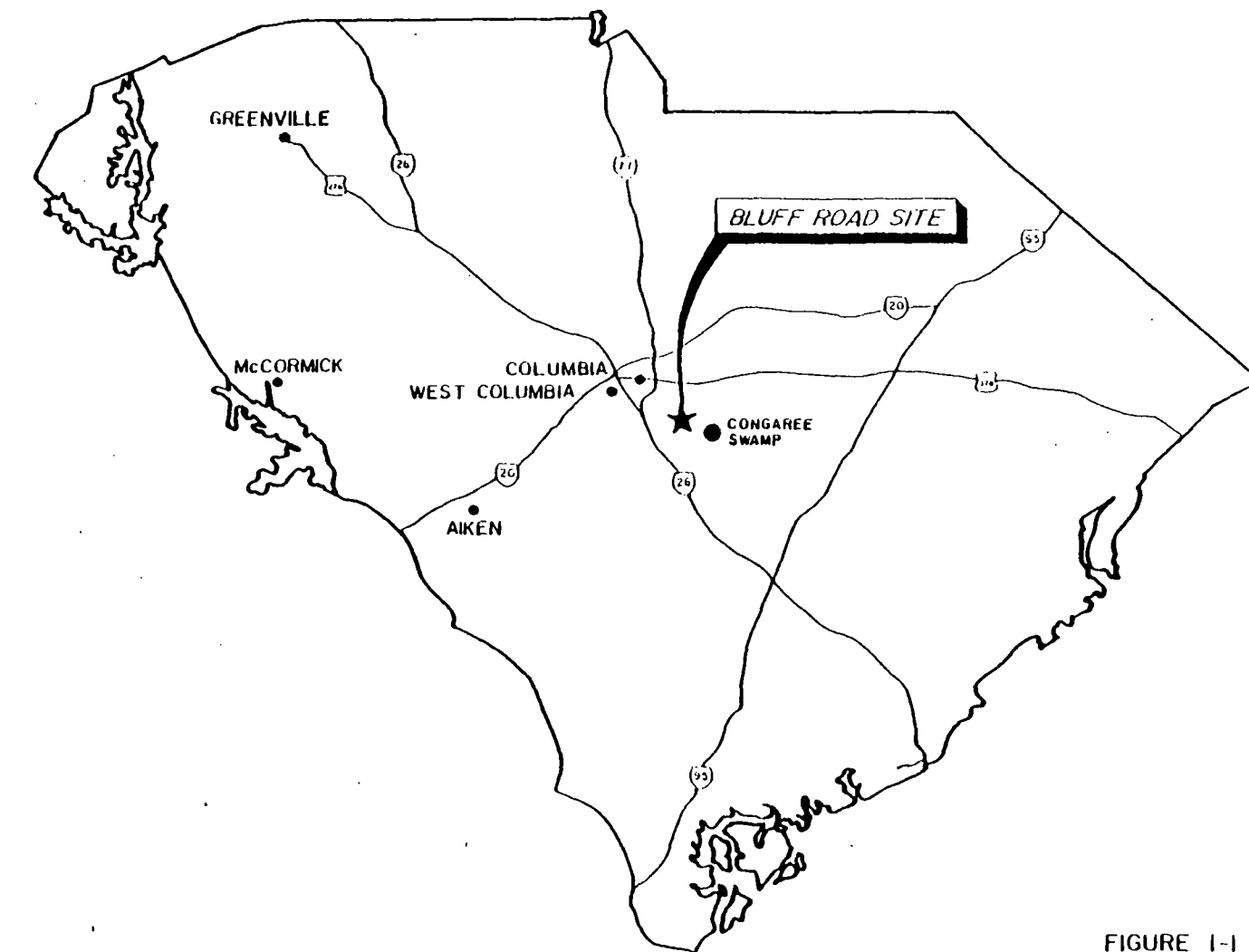
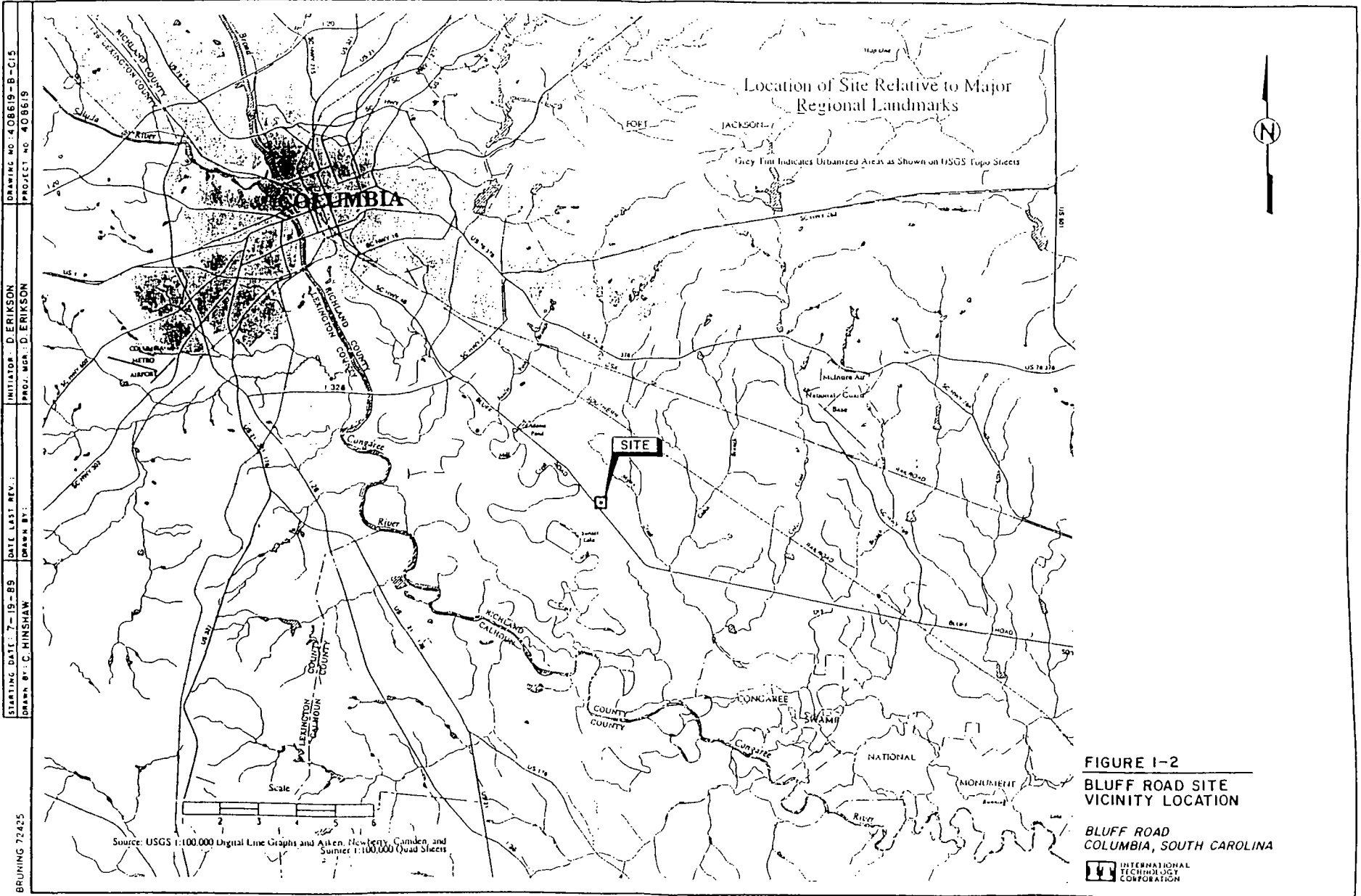
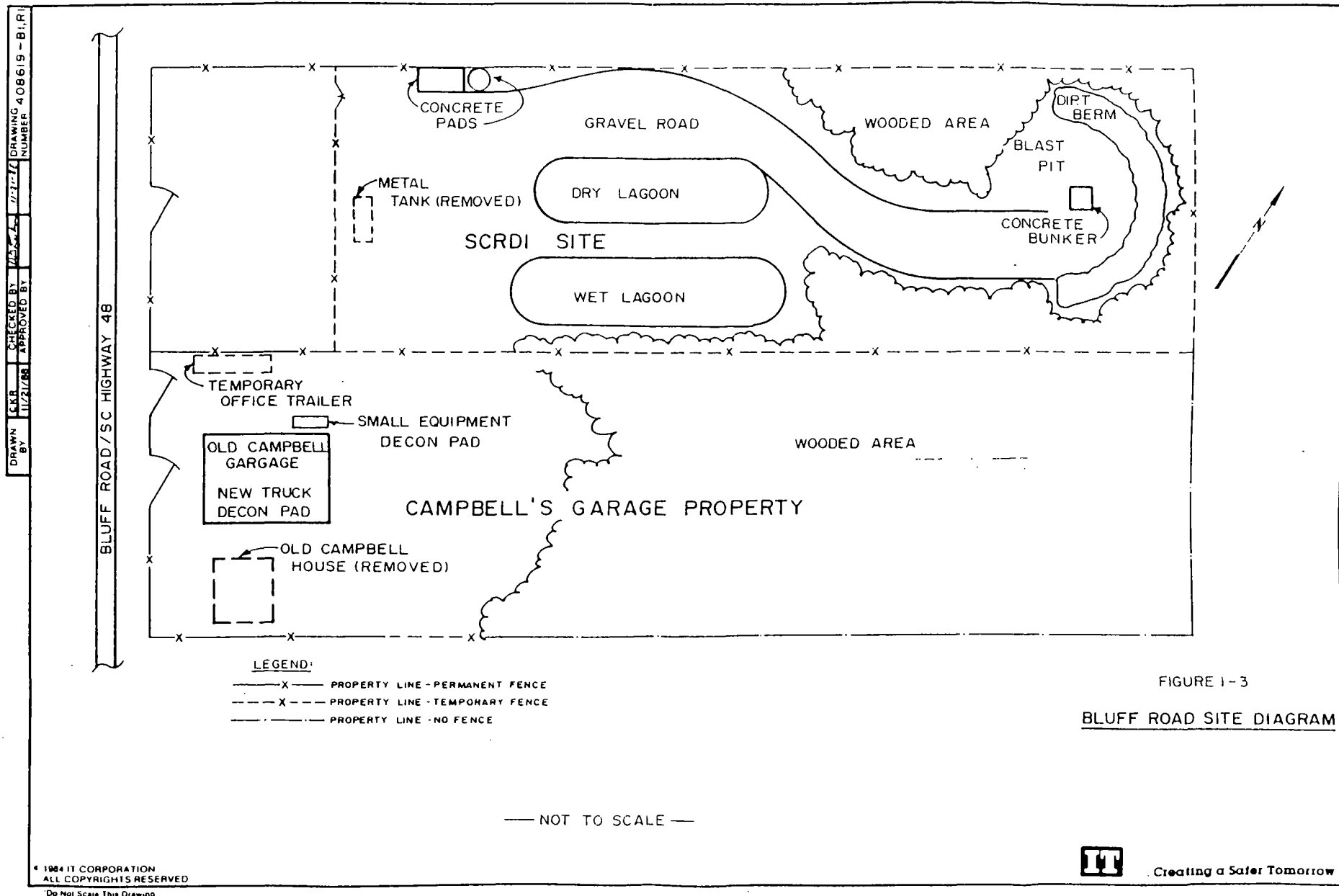


FIGURE 1-1
SITE LOCATION

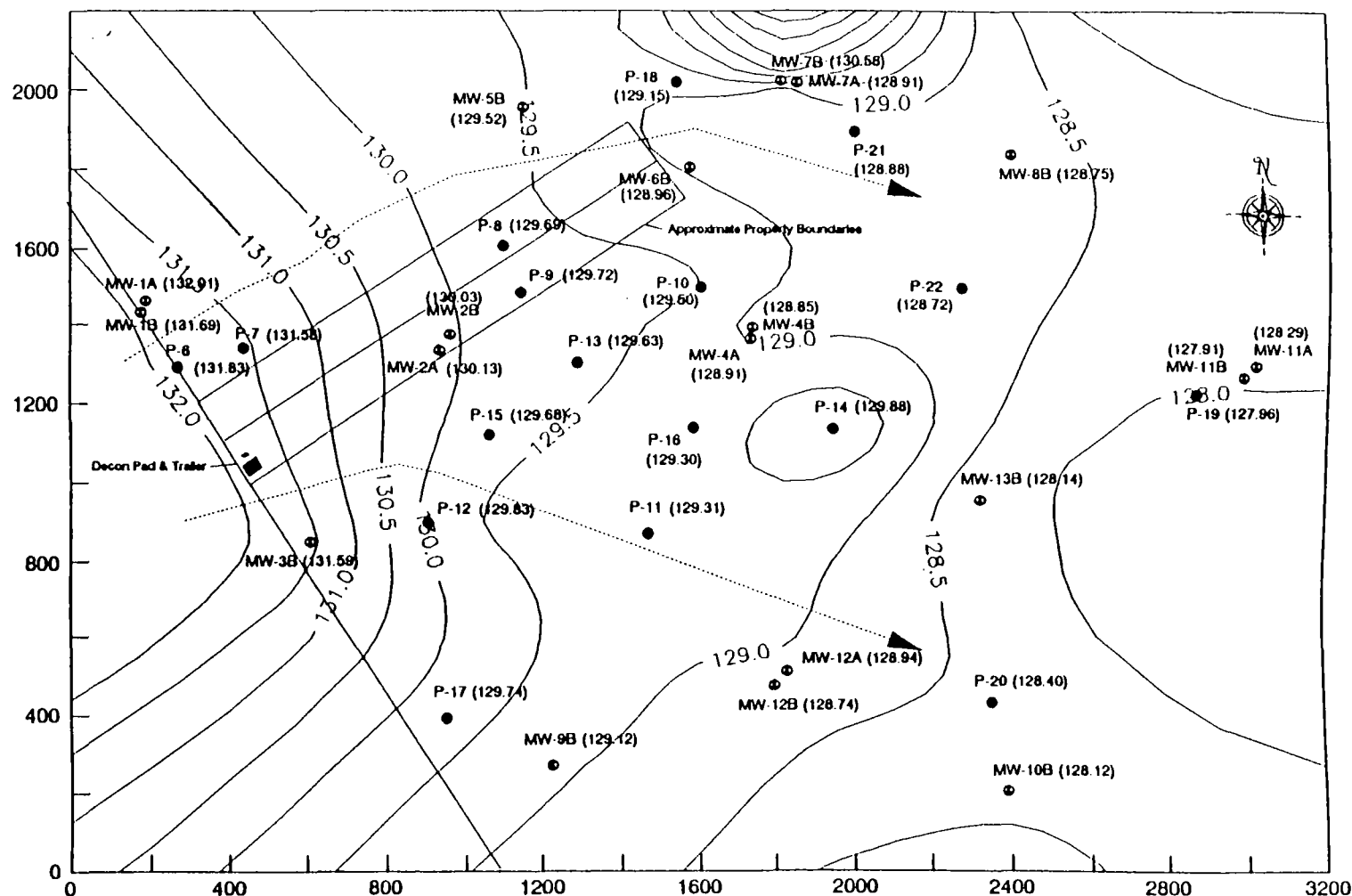
BLUFF ROAD
COLUMBIA, SOUTH CAROLINA







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LEGEND

- GROUND WATER ELEVATION CONTOUR LINE
(Elevation in feet Mean Sea Level)
- GROUND WATER FLOW DIRECTION
- IT WELL (Installed 1989)
- GOLDER WELL (Installed 1985)

SCALE: 1" = 435 ft

NOTE: CONTOUR INTERVAL = 0.5 ft

FIGURE 1-4.

GROUND WATER CONTOUR MAP
FOR SHALLOW AQUIFER SYSTEM ON 5-24-89

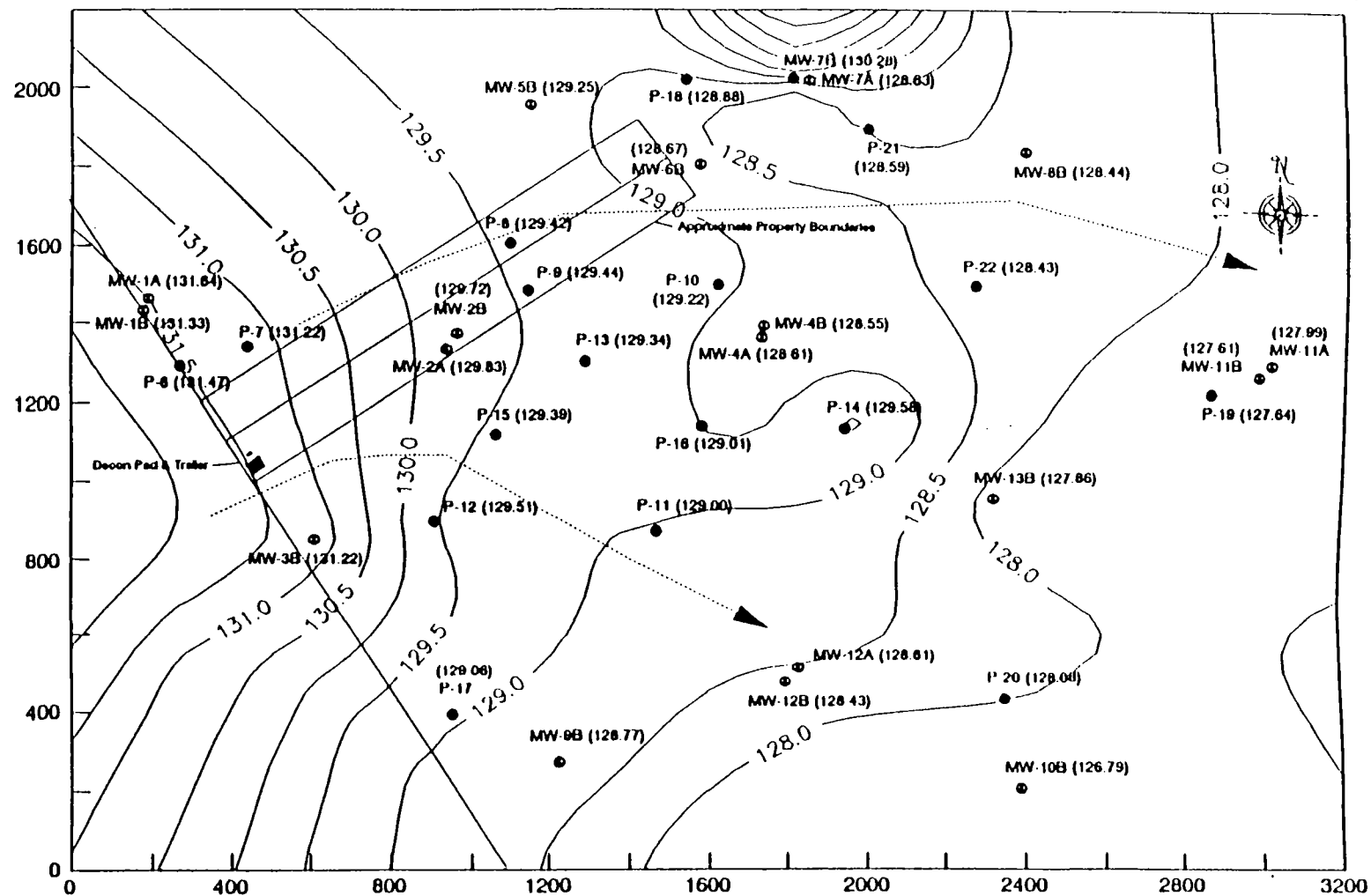


FIGURE 1-5

GROUND WATER CONTOUR MAP
FOR SHALLOW AQUIFER SYSTEM ON 6-01-88

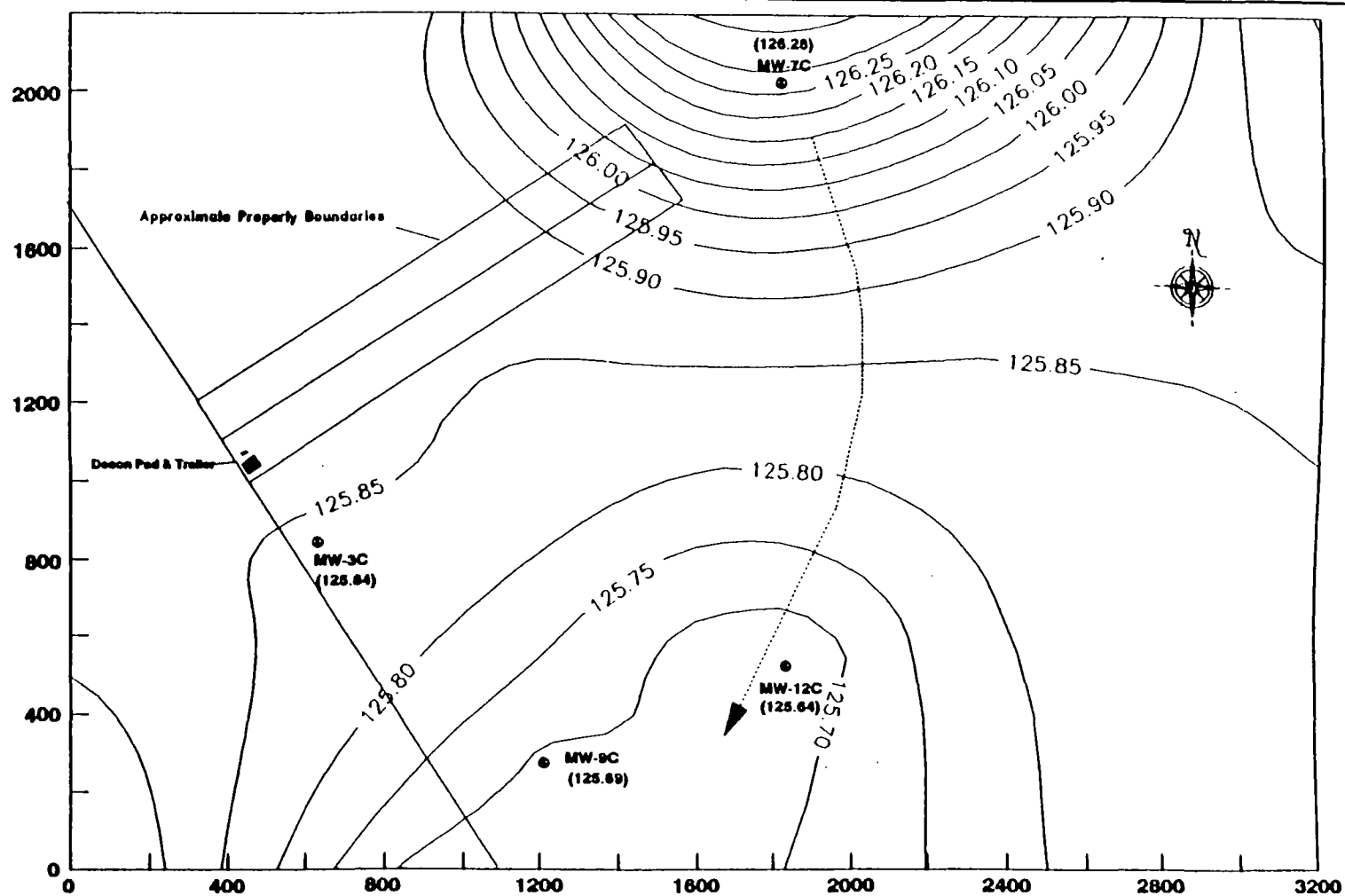
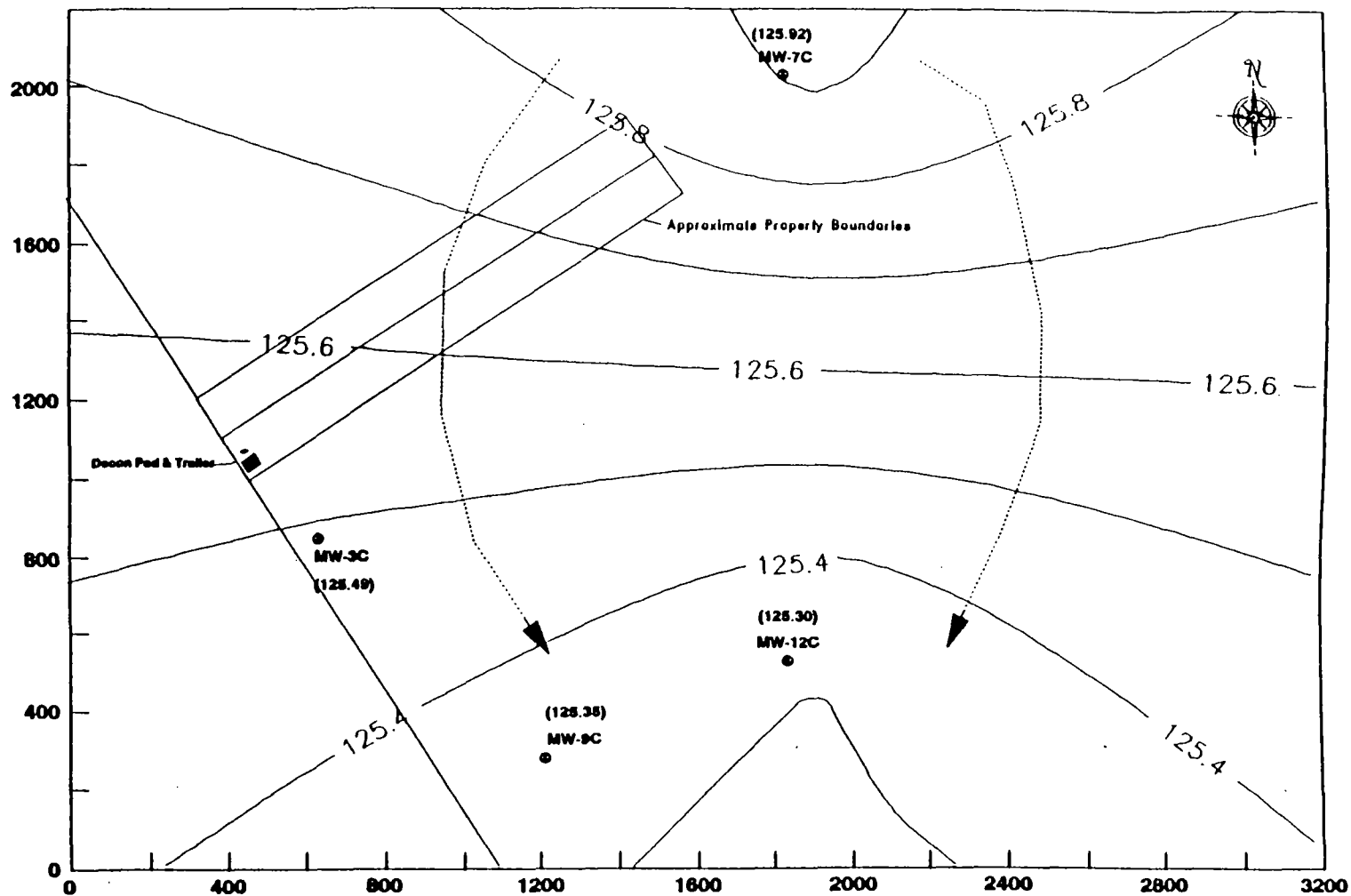


FIGURE 1-6

**GROUND WATER CONTOUR MAP
FOR DEEP AQUIFER SYSTEM ON 5-24-89**



LEGEND

- 125.0 —
GROUND WATER ELEVATION CONTOUR LINE
(Elevation in feet Mean Sea Level)
- IT WELL (Installed 1999)
- GOLDER WELL (Installed 1995)
- ▶ GROUND WATER FLOW DIRECTION

SCALE: 1" = 435 ft

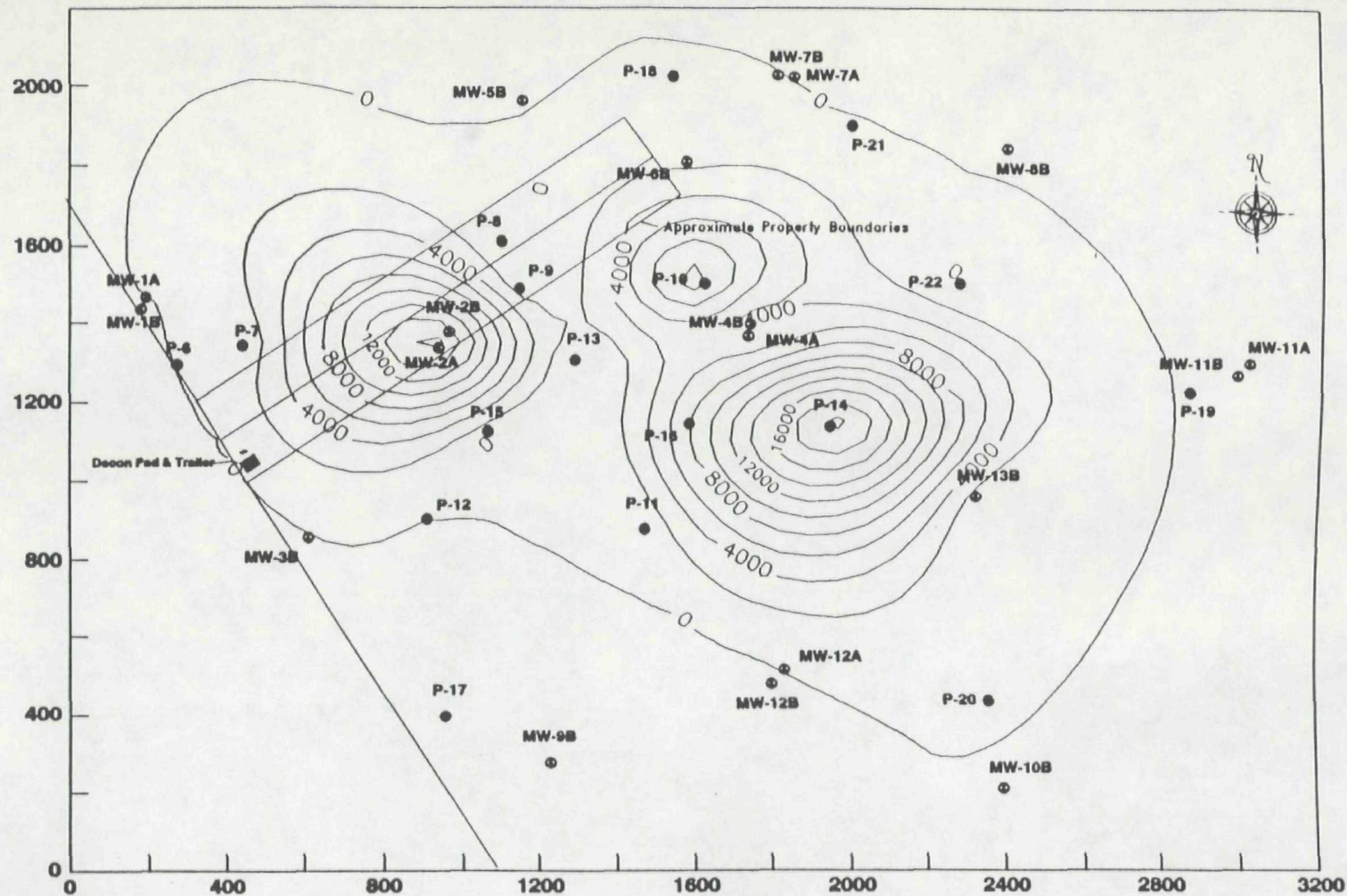
NOTE: CONTOUR INTERVAL = 0.1 ft

FIGURE 1-7

**GROUND WATER CONTOUR MAP
FOR DEEP AQUIFER SYSTEM ON 6-01-00**



INTERNATIONAL
TECHNOLOGY
CORPORATION



LEGEND

— 4000 —
 CHEMICAL CONCENTRATION CONTOUR LINE
 (Concentration in parts per billion)

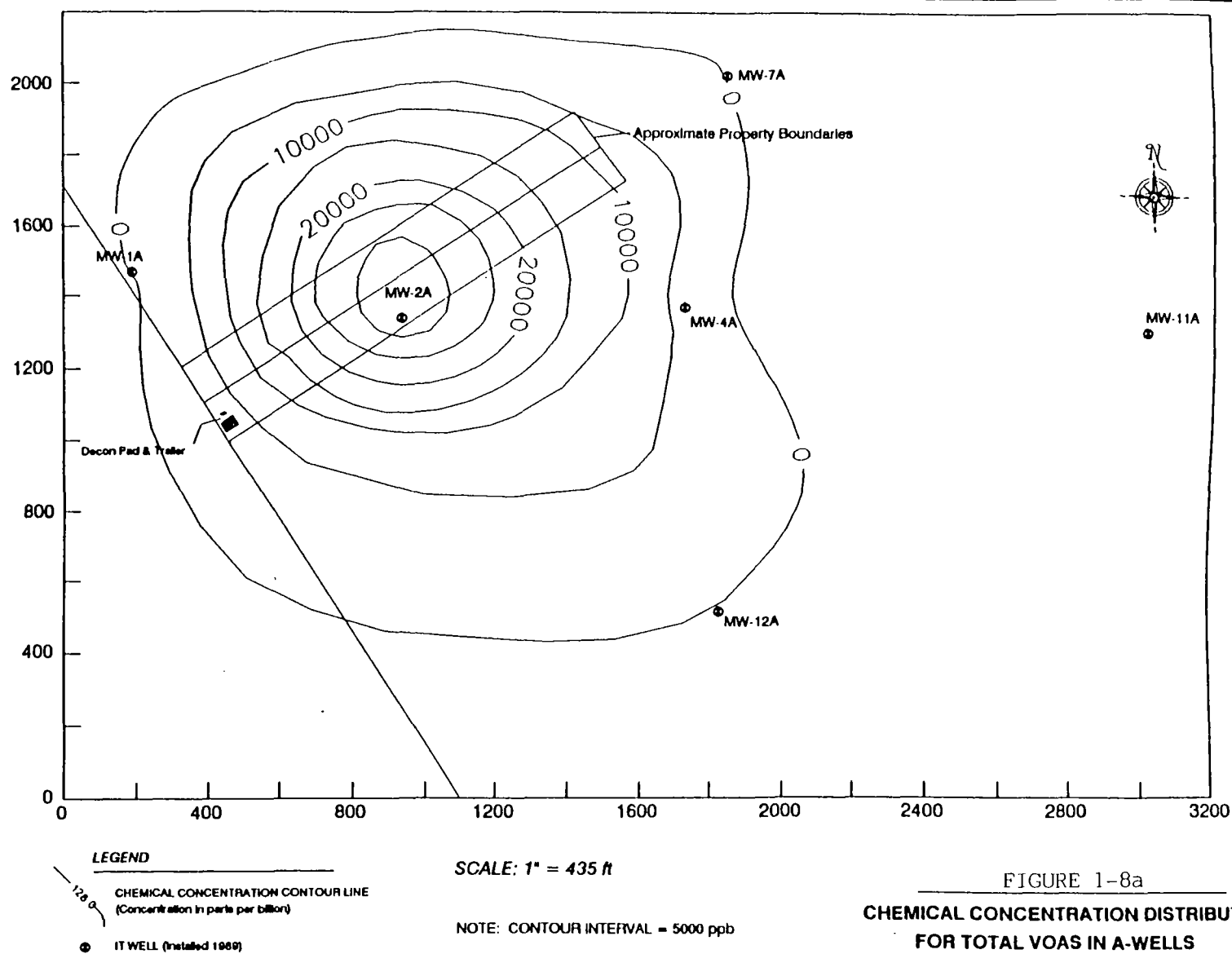
- IT WELL (Installed 1999)
- GOLDER WELL (Installed 1998)

SCALE: 1" = 435 ft

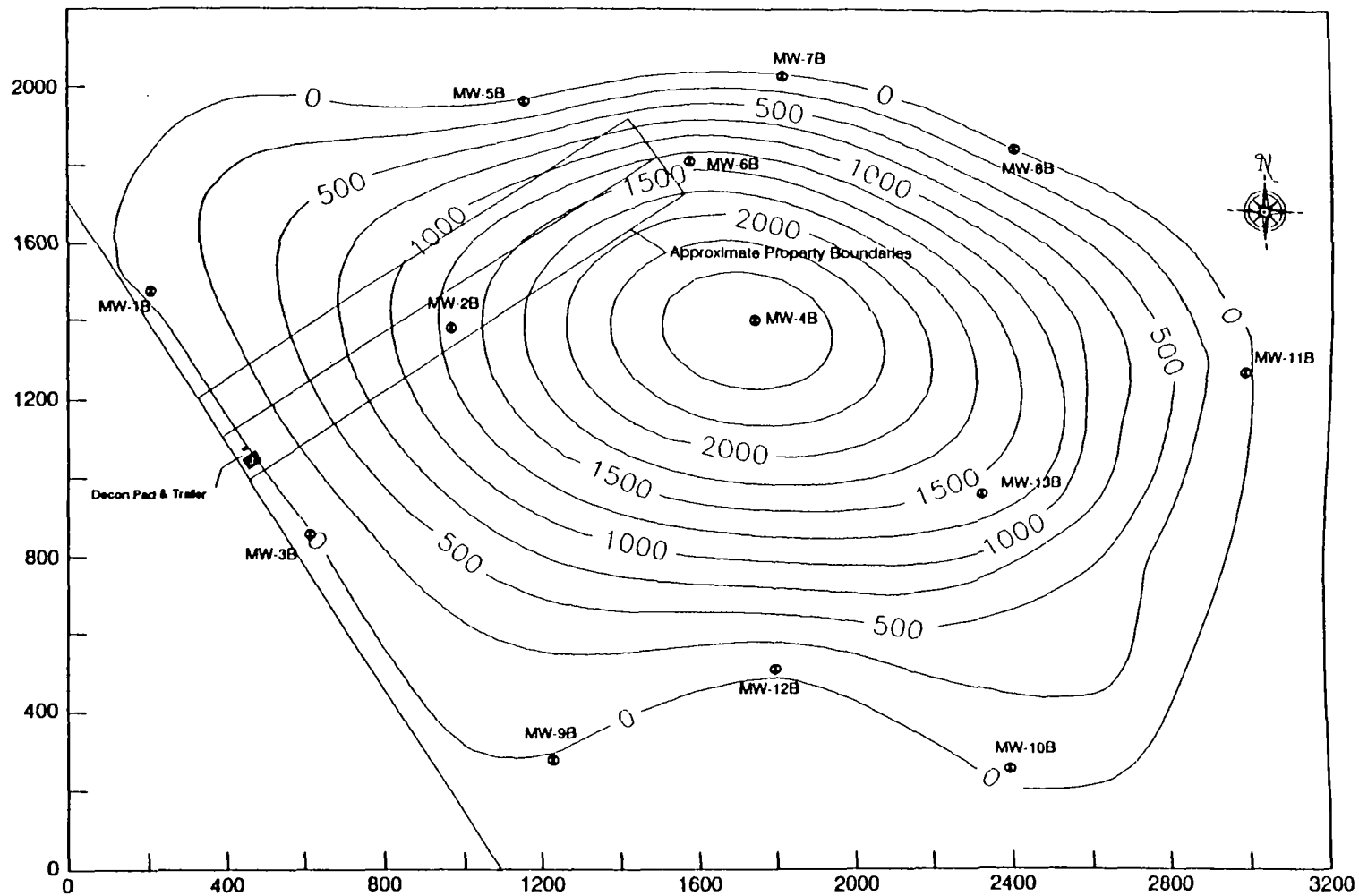
NOTE: CONTOUR INTERVAL = 2000 ppb

FIGURE 1-8

**CHEMICAL CONCENTRATION DISTRIBUTION MAP
 FOR TOTAL VOAS IN ALL UPPER AQUIFER WELLS**



49 0065



LEGEND

- CHEMICAL CONCENTRATION CONTOUR LINE
(Concentration in parts per billion)
- IT WELL (Installed 1989)

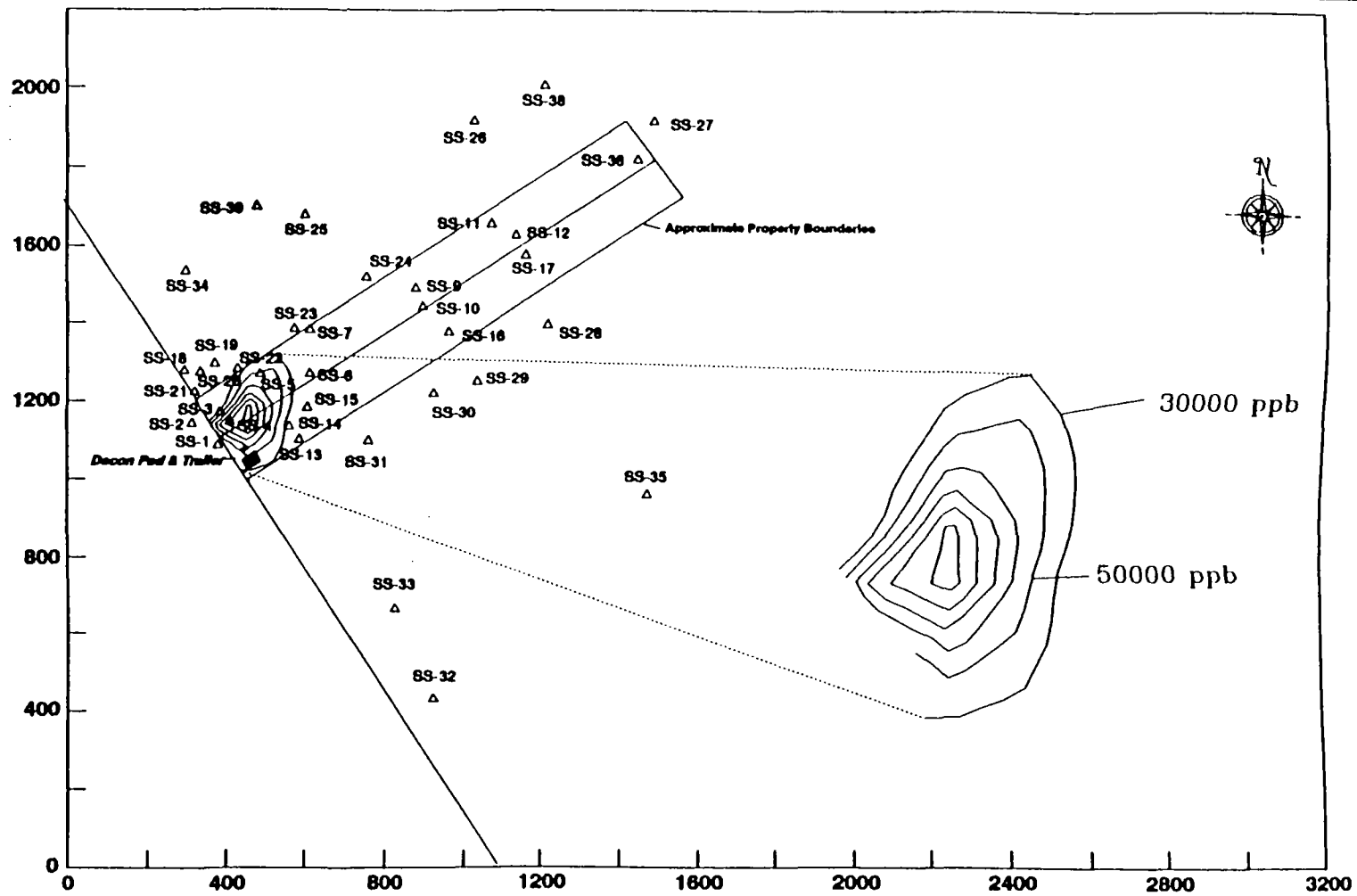
SCALE: 1" = 435 ft

NOTE: CONTOUR INTERVAL = 250 ppb

FIGURE 1-8b

**CHEMICAL CONCENTRATION DISTRIBUTION MAP
FOR TOTAL VOAS IN B-WELLS**

△ SS-37



LEGEND

- 10,000 —
CHEMICAL CONCENTRATION CONTOUR LINE
(Concentration in parts per billion)
- △ SURFACE SOIL SAMPLE

SCALE: 1" = 435 ft

NOTE: CONTOUR INTERVAL = 20000 ppb

FIGURE 1-9

CHEMICAL CONCENTRATION DISTRIBUTION MAP
FOR TOTAL VOAs* IN SURFACE SOIL SAMPLES

* EXCLUDES ACETONE AND METHYLENE CHLORIDE

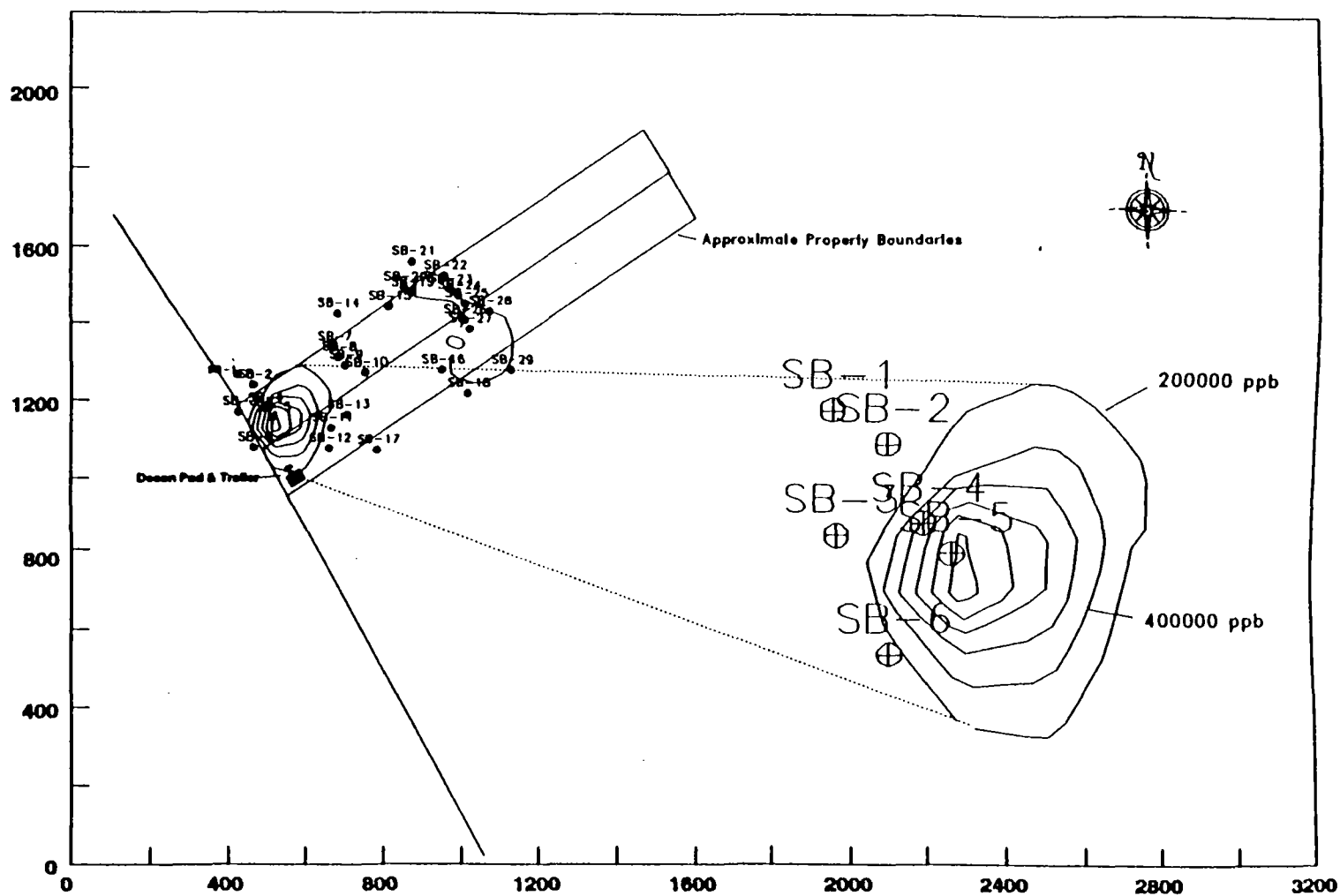
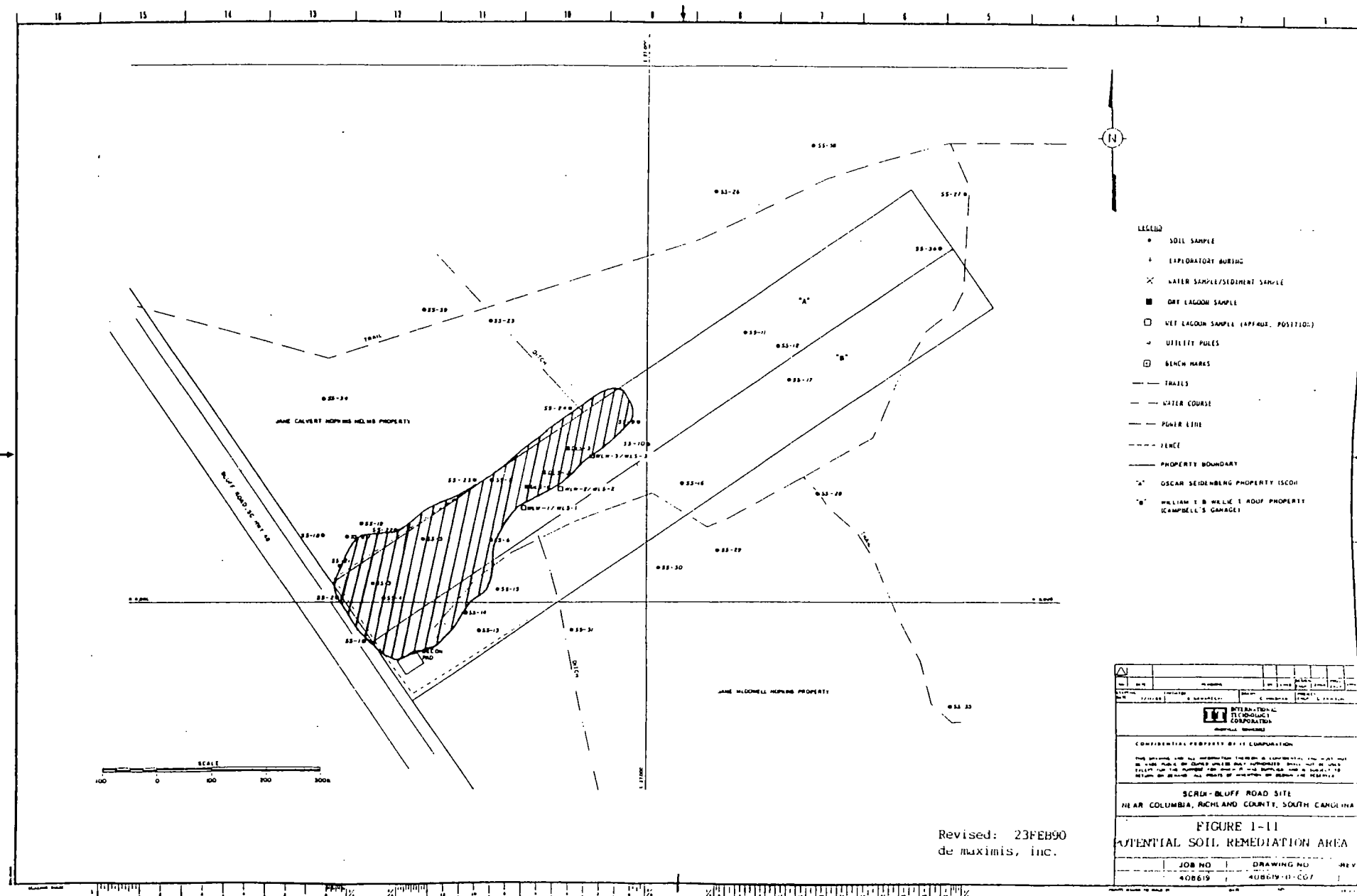


FIGURE 1-10

CHEMICAL CONCENTRATION DISTRIBUTION MAP
FOR TOTAL VOAs* IN SOIL BORINGS

* EXCLUDES ACETONE AND METHYLENE CHLORIDE



SECTION 2.0 REMEDIAL ACTION OBJECTIVES

The purpose of this Section is to briefly summarize the Risk Assessment; develop the remedial action objectives to be used to screen alternatives; and finally provide goals which will be considered to attain the remedial action objectives.

2.1 Risk Assessment Summary

As part of the Remedial Investigation (RI) a risk assessment was conducted by IT Corporation to evaluate the potential for off-site migration of chemicals from the Bluff Road Site and the impacts, if any, on public health and/or the environment. The risk analysis evaluated the potential impact upon public health and/or the environment of all chemicals which are classified by CAG as Class A, B, and C carcinogens and selected noncarcinogenic indicator chemicals.

2.1.1 Migration and Exposure Pathway Analysis

The extent of chemicals in environmental media at the Bluff Road Site was shown to be limited to the on-site soils and the shallow ground-water aquifer underlying the site. No elevated levels of site-related chemicals were found in off-site soil samples, sediment samples from drainage ditches, the deep ground water aquifer, or in surface water samples from drainage ditches or local creeks (Section 1.4). The primary potential route of off-site migration was shown to be via the shallow water aquifer. This aquifer may recharge Myers Creek, 3,200 feet northeast of the site boundary, however site-related chemicals have not been detected in Myers Creek.

Well surveys have shown that no known domestic wells exist within the study area that draw water from the shallow aquifer. The shallow aquifer may recharge Myers Creek and migration into this creek remains

possible under current conditions. Recreational activities in Myers Creek which is classified by the State as a Class A stream are limited to fishing. The creek is a shallow, black-water creek and is not used for swimming or water sports activities. Prolonged contact of large areas of exposed skin with the waters of Myers Creek does not appear to occur.

The wooded area surrounding the site is remote and routine foot travel in this area is not common. Access to the Bluff Road Site is limited either through natural or man-made barriers; therefore, the likelihood of direct dermal contact with the soils is unlikely. There are no human activities near the site that would require a person to spend long periods of time on site or adjacent to the site. Therefore, direct inhalation of site-related, particulate-bound chemicals was not considered in the risk assessment.

Deer hunting is the major activity in the area and under a potential exposure scenario deer may ingest site-related chemicals from drinking water in Myers Creek and by consuming vegetation growing on the Bluff Road Site. The effects of potential bioconcentration in the tissue of deer and fish has been determined by the Agency to be negligible at the site.

2.1.2 Exposure Assessment for Current Use Scenarios

Two exposure scenarios were used to estimate the intake of venison and fish, based upon consumption surveys and other data. Both scenarios represented a specific subset of the general population - a dedicated hunter, or a person who spends a large amount of his leisure time hunting and fishing. It was assumed that an individual potentially receiving an average exposure (AEI) would consume venison about once weekly at the evening meal. Half of the AEI's average daily fish consumption of 20 grams (USDA, 1985) would

come from fish caught in Myers Creek. A maximally exposed individual (MEI) was assumed to consume venison about twice weekly at the evening meal. All of the MEI's fish intake was assumed to come from fish caught in Myers Creek. The estimated applied daily intakes for an AEI ranged from 1.5×10^{-11} mg/kg-day for xylene to 1.82×10^{-7} mg/kg-day for 2-chlorophenol). The analogue range of estimated intakes for a MEI was 2.29×10^{-11} mg/kg-day for xylene to 3.64×10^{-7} mg/kg-day for 2-chlorophenol.

2.1.3 Risk Characterization for Current Use Scenario

In weighing acceptable residential exposures to potentially carcinogenic compounds, an acceptable level of risk must be determined. Cancer is a significant cause of death in the United States with a background incidence of about 3 in 10 (280,000 cases in a population of 1,000,000) (American Cancer Society, 1988). Approximately 80 percent of these cases result in death directly attributable to the disease.

Incremental lifetime cancer risk (also referred to as excess cancer risk) is defined as the estimated increased risk that occurs over an assumed average lifespan of 70 years (EPA, 1986) as the result of exposure to a specific known carcinogen. Thus, an incremental lifetime cancer risk of one in a million (1×10^{-6}) may be interpreted as an increase in the baseline cancer incidence from 280,000 per million population to 280,001 per million population.

Based on the scientific evidence and the regulatory precedence of the acceptable risk ranges set for exposure to carcinogens in drinking water and at Superfund site cleanups, rigid adherence to an incremental lifetime cancer risk of 1×10^{-6} may be unwarranted in the exposure scenario developed in the current risk assessment.

The incremental cancer risk estimates for chemicals classified as Class A, B, or C carcinogens are the estimated probabilities of increase in the number of cancer cases within a population. The incremental cancer risk estimates for potential current use exposures to site-related chemicals classified as carcinogens ranged from 1.59×10^{-8} for 1,1-dichloroethylene to 3.36×10^{-12} for methylene chloride for the AEI. The incremental risk values for potential MEIs ranged from 3.17×10^{-8} to 6.72×10^{-12} for these chemicals, respectively.

The hazard index (HI) was used to evaluate the risk associated with exposure to noncarcinogenic chemicals. The HI does not define dose-response relationships and its numerical value should not be construed to be a direct estimate of risk. The HI is only a numerical indication of the nearness to acceptable limits of exposure or the degree to which acceptable exposure levels are exceeded. As this index approaches unity, concern for the potential hazard of the mixture increases. Exceeding unity does not in itself imply a potential hazard. It does suggest that a given situation should be more closely scrutinized (EPA, 1986).

The HIs for the AEI ranged from 1.65×10^{-3} for mercury to 1.15×10^{-9} for xylene. For the MEI, none of the HIs exceeds that estimated for mercury (3.29×10^{-3}). This value approaches nearly three orders of magnitude below the benchmark value of unity.

2.1.4 Exposure Assessment for Potential Future Use Scenarios

Potential future use scenarios have been developed to estimate any risks associated with the presence of site-related chemicals in the shallow aquifer and in surficial soils.

No foot travel by trespassers have been observed by site personnel. The terrain is not conducive to this activity; furthermore, the Bluff Road Site is currently fenced.

Exposure scenarios were developed for an average exposed individual (AEI) wearing shoes, long-sleeve shirt and long pants and a maximally exposed individual (MEI) wearing shoes, short-sleeve shirt and shorts (EPA, 1989). A discussion of the exposure model and the assumptions used are presented in Appendix G of the RI.

The estimated applied daily intakes for the AEI range for the trespasser scenario from 3.18×10^{-10} mg/kg-day for chloroform to 4.11×10^{-6} mg/kg-day for chromium. For the MEI, the range of estimated intakes is 1.5×10^{-9} mg/kg-day for chloroform to 1.90×10^{-5} mg/kg-day for chromium.

A potential future-use drinking water scenario was developed to estimate any risks associated with the presence of site-related chemicals in the shallow aquifer. Estimated daily intakes of suspected carcinogens for each stage of childhood and adolescence ranged from 8.05×10^{-6} mg/kg/day of bis (2-ethylhexyl) phthalate (BEHP) for the late adolescent average exposed individual (AEI) to 2.21×10^{-2} mg/kg/day for 1,1-dichloroethane (1,1-DCA) for the preschool maximally exposed individual (MEI). The adult estimated intakes ranged from 1.28×10^{-5} mg/kg/day for BEHP (AEI) to 1.15×10^{-2} mg/kg/day for 1,1-DCA (MEI).

For noncarcinogens, the estimated intakes for childhood and adolescence ranged from 2.83×10^{-6} mg/kg/day of mercury for the late adolescent AEI to 3.95×10^{-2} mg/kg/day of acetone for the infant MEI. Estimated adult exposures to

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noncarcinogens ranged from 4.48 to 10^{-6} mg/kg/day for mercury (AEI) to 2.17×10^{-6} mg/kg/day for mercury to (AEI) 2.17×10^{-2} mg/kg/day for acetone (MEI).

2.1.5 Risk Characterization for Potential Future Use Scenarios

The estimated incremental lifetime cancer risks for childhood and adolescence for the drinking water scenario are given in Table 5-19 of the RI. The estimated incremental lifetime cancer risk for AEI for children ranged from 7.67×10^{-4} for 1,1-dichloroethylene to 3.02×10^{-9} for bis (2-ethylhexyl) phthalate. The incremental cancer risk for the MEI ranged from 8.84×10^{-4} for 1,1 dichloroethylene to 3.48×10^{-9} for BEHP.

The estimated incremental lifetime cancer risks for the drinking water scenario for adults are given in Table 5-15 of the RI. The estimated incremental lifetime cancer risks for AEI for adults ranged from 1.43×10^{-3} for 1,1-dichloroethylene to 5.63×10^{-9} for bis (2-ethylhexyl) phthalate. The incremental cancer risk for the MEI ranged from 2.05×10^{-3} for 1,1-dichloroethylene to 8.04×10^{-9} for bis (2-ethylhexyl) phthalate.

The hazard indices for noncarcinogens for the drinking water scenario for the AEI ranged from 3.33×10^{-3} for mercury to 2.28×10^0 for 2-chlorophenol for the infant; 3.01×10^{-3} for mercury to 2.07×10^0 for 2-chlorophenol for a child; and 1.41×10^{-3} for mercury to 9.69×10^{-1} for 2-chlorophenol for late adolescents. The range of MEI health indices for the previous chemicals ranged from 5.83×10^{-3} to 4.00×10^0 for infants; 3.32×10^{-3} to 2.28×10^0 for a child; and 1.52×10^{-3} to 1.04×10^0 for the late adolescent.

The hazard indices for the drinking water scenario for the adult AEI ranged from 2.24×10^{-3} for mercury to 1.54×10^0 for 2-chlorophenol. The range for the MEI is 3.20×10^{-3} for mercury to 2.19×10^0 for 1,2-chlorophenol.

The HI for the trespasser scenario for the AEI ranged from 3.28×10^{-8} for chloroform to 3.41×10^{-4} for trichloroethylene (TCE). The HI range for the MEI is 1.51×10^{-7} for chloroform to 1.58×10^{-3} for TCE. The highest HI was nearly three orders of magnitude below the benchmark value of one. Therefore, the presence of site-related chemicals in the soils at the Bluff Road Site do not present a potential risk to the health of potential adult or child trespassers on the site.

2.1.6 Environmental Assessment

Chemical concentrations to which aquatic populations in Myers Creek may be exposed ranged from 3.69×10^{-4} mg/L for acetone to 1.09×10^{-7} mg/L for mercury. The predicted chemical concentrations in Myers Creek, will not have a significant impact upon the indigenous aquatic populations. To assess the possible impact of chemicals migrating into Myers Creek the maximum acceptable toxicant concentration (MATC) was determined for the most sensitive species which may be found in Myers Creek. The MATC is the calculated concentration of a chemical which will not have an adverse effect upon a chronically exposed population. The predicted chemical concentrations in Myers Creek are over three orders of magnitude lower than the respective MATCs. The contribution from the Bluff Road Site would have to be over 1,000 times higher than the predicted rate to have an adverse effect upon aquatic populations.

Acceptable daily doses for deer were determined based upon the available published literature. The applied daily dose for deer ranged from 4.51×10^{-2} mg/kg-day for 1,1,2,2-tetrachloroethane to 2.59×10^{-9} mg/kg-day for 1,1,2-trichloroethane. All of the applied daily intakes for deer except 1,1,2,2-tetrachloroethane are more than an order of magnitude below the acceptable daily intakes. However, this chemical occurred in only one soil sample. Frequent exposure to this level is improbable. Therefore, the predicted exposure intakes for deer would be expected to be below those intakes which may have an adverse effect upon the deer populations in the area.

2.1.7 Conclusions

The overall conclusions for the current site uses are that based on current knowledge of the site no significant levels of public health or environmental risks are associated with the off-site migration of chemicals at the Bluff Road Site. For the hypothetical future use scenarios, there appear to be concentrations of site-related chemicals in the shallow aquifer that may result in elevated levels of exposure only if all the health protective assumptions of the scenario are realized.

The assumptions used in this assessment were health and environmentally protective, and estimations in this assessment of potential intakes to both humans and wildlife may be greater than any actual exposures, should they occur.

2.2 REMEDIAL ACTION OBJECTIVES

The risk assessment performed as part of the Bluff Road Site RI indicates that the primary environmental medium that might adversely affect human health or the environment is the

contaminated ground water based on the hypothetical future use scenario. To mitigate the potential future risks as defined by the risk assessment the following remedial action objectives have been established for the ground water plume:

- o Reduce potential risks to human health associated with ingestion of ground-water from the upper aquifer containing contaminants at levels in excess of ARARs.
- o Reduce contaminant concentrations in the upper aquifer to meet or exceed identified ARARs (see Section 3).
- o Minimize expansion of the current upper aquifer plume.
- o Minimize the risk of contaminating the deep aquifer.
- o Reduce or eliminate the existing ground-water contaminant sources (i.e. contaminated soil).

These objectives will be used as a basis for screening the remedial technologies and for developing remedial action alternatives for the ground water plume.

To attain these remedial action objectives, the following goals will be considered in the selection of the remedial action:

- Implement a remedial action program which will meet or exceed ARARs (See Section 3).
- Implement a remedial action program which will permanently and significantly reduce the mobility, toxicity, or volume of the site constituents.

Although the soils at the Bluff Road site do not present a significant risk to human health, they contain contaminants that may leach from the soils to the ground water. Therefore, treatment of the soils will positively impact the achievement of the remedial action objectives for the ground water.

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Remedial technologies for soils will be screened based solely on their ability to meet or exceed the soil target cleanup levels.

SECTION 3.0
DEVELOPMENT OF ARARS AND
REMEDATION GOAL

3.1 General

3.1.1 Definition of ARARs

The Remedial Investigation/Feasibility Study (RI/FS) was conducted pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and in conformance with the guidelines, criteria, and considerations set forth in the National Contingency Plan (NCP) and the Superfund Amendments and Reauthorization Act (SARA). Consistent with the CERCLA/SARA/NCP framework is the requirement that the remedial action must comply with all legally applicable or relevant and appropriate requirements (ARARs). Applicable requirements are those federal and state requirements that would apply to conditions at a CERCLA site under any circumstance. Federal statutes that are specifically cited in CERCLA include the Toxic Substances Control Act (TSCA), the Safe Drinking Water Act (SDWA), the Clean Air Act (CAA), the Clean Water Act (CWA), and the Marine Protection Research and Sanctuaries Act. Relevant and appropriate requirements are those federal and state human health and environmental requirements that apply to circumstances sufficiently similar to those encountered at CERCLA sites. In such cases, application of these requirements would be appropriate although not mandated by law. Relevant and appropriate requirements are intended to carry the same weight as legally applicable requirements.

At the completion of remediation, the only requirements that must be complied with are those that describe the level at which a hazardous substance, pollutant or contaminant, should be found in the environment, or those standards that specify a

means of controlling releases of hazardous substances, pollutants or contaminants.

The agency has also identified certain guidance as to-be-considered material (TBC). TBCs are non-promulgated advisories or guidance issued by federal or state government that are not legally binding and do not have the status of potential ARARs. In some circumstances, TBCs will be considered as part of the site risk assessment and may be used in determining the necessary level of cleanup for protection of health or the environment.

The universe of environmental standards and controls was reviewed to determine which of them had a bearing on remedial action at the Site. A list of Standards, Requirements, Criteria, or Limitations Evaluated for ARARs determination is presented in Table 3-1.

3.1.2 Types of ARARs

EPA has provided guidance on the overall application of the ARARs concept into the RI/FS process (EPA, 1988a). More specific guidance on compliance with ARARs has also been provided by the agency (EPA, 1987b; EPA, 1988a). In accordance with this guidance, ARARs are to be progressively identified and applied on a site-specific basis as the RI/FS proceeds. The initial step in the process entails the survey of all potential ARARs for the remedial action process at the subject site. The potential ARARs considered for the Bluff Road Site were categorized into the following EPA-recommended classifications:

- o Chemical-specific ARARs are usually health or risk-based numerical values or methodologies which, when applied to site-specific conditions, result in the establishment of numerical values for each chemical of

concern. These values establish the acceptable amount or concentration of a chemical that may be found in or discharged to the ambient environment.

- o Performance, design, or other action-specific ARARs are usually technology - or activity-based requirements or limitations on actions taken with respect to waste management and site cleanup.
- o Location-specific ARARs are restrictions placed on the concentration of a chemical or the conduct of activities solely because they occur in special locations.

The next step in the ARARs process is the integration of the statutory and regulatory requirements with site-specific factors to evaluate whether a site is currently in compliance with all public health and environmental standards and, if not, to establish remedial action objectives in terms of media-specific cleanup levels that would achieve compliance.

The degree to which site-specific factors are incorporated into the ARAR development process varies considerably. In the case of hazardous chemicals, the evaluation of site-specific factors is an integral part of the ARARs process even when prerequisites based on statutory or regulatory requirements exist, (EPA, 1988f). As an example, for Maximum Contaminants Levels (MCLs) promulgated under the SDWA to be considered as ARARs at a site, the surface water or ground water media under consideration should be demonstrated to be potable and usable as drinking water, either currently or at some future date. Flexibility is also provided in modifying a standard such as an MCL based on evidence that site-specific factors are different than those used in the derivation of the MCLs.

For chemicals for which ARARs are not available, EPA has provided guidance on the use and application of TBCs, such as

carcinogenic potency factors (CPFs) or reference doses (RFDs) (EPA, 1987b, 1988a). While not actually ARARs, these data may be used to determine risk-based cleanup levels in a site-specific approach.

3.2 ARARs and TBCs for the Bluff Road Site

The establishment of final federal and state ARARs for hazardous chemicals for the evaluation of remedial action alternatives at the Bluff Road Site was a progressive, multistep process that included the risk assessment. Site-specific factors were used to develop appropriate exposure scenarios that defined the bounds of the risk estimates for each remedial alternative.

3.2.1 Chemical Specific ARARs

3.2.1.1 Ground water

Ground water at the Bluff Road Site is designated as Class GB in accordance with the South Carolina water classification system. The GB designation is used to classify water quality suitable as a potential drinking water supply. Therefore, Federal and State regulations governing the quality and usage of drinking water is applicable.

The Safe Drinking Water Act and the State Primary Drinking Water Regulations establish Maximum Contaminant Levels (MCLs) for numerous organic and inorganic constituents. The Target Cleanup Levels (TCLs) shown in Table 3-2 were established based on MCLs and proposed MCLs. Where MCLs were not available, risk based numbers were calculated as indicated by the appropriate table footnotes.

3.2.1.2 Soils

Although there were no ARARs identified for site soils, the

potential for contaminants leaching from the soils as a continuing source that could further degrade ground water quality was considered. Therefore, a soil leachability model was used to calculate TCLs as shown in Tables 3-3 and 3-4. Where the model calculated soil target cleanup levels (TCLs) lower than the ground water MCL for a specific constituent, the MCL was used as the soil TCL. The model and appropriate calculations are provided in Appendix A.

3.2.2 Location Specific ARARs

Since the Bluff Road Site may affect Myers Creek through discharge from the shallow aquifer, the Fish and Wildlife Coordination Act would be applicable. If the site or surrounding areas is designated as a wetlands the following ARARs would potentially apply:

- o Clean Water Act, Section 404
- o Protection of Flood Plain (40 CFR 6, Appendix A) Fish and Wildlife Coordination Act
- o General RCRA Facility Location Standards (40 CFR 264.18)

3.2.3 Action Specific ARARs

The action specific ARARs for this site are summarized in Table 3-5. The ARARs are divided into three categories:

- o ARARs for actions taken in all alternatives
- o ARARs for actions involving soil treatment
- o ARARs for actions involving ground water treatment

The first category are requirements for safety and health, hazardous waste facilities, and transportation. The second category are requirements for excavation, thermal treatment, soil vapor extraction, and clean closure of site soils. The

third category includes ARARs concerning discharge of treated ground water and related air emissions.

3.2.4 Other Federal and State Criteria, Advisories and Guidance

Other to-be-considered (TBC) Criteria, Advisories and Guidance which were used in the public health evaluations and determinations of some Target Cleanup Levels are shown in Table 3-6.

Table 3-1. Standards, Requirements, Criteria, or Limitations Evaluated for ARARs Determination

-
- o Safe Drinking Water Act
 - o Clean Water Act
 - o Solid Waste Disposal Act
 - o Occupational Safety and Health Act
 - o Hazardous Materials Transportation Act
 - o National Historic Preservation Act
 - o Archeological and Historical Preservation Act
 - o Historic Sites, Buildings, and Antiquities Act
 - o Fish and Wildlife Coordination Act
 - o Endangered Species Act
 - o Rivers and Harbors Act of 1899
 - o Wilderness Act
 - o Scenic River Act
 - o Coastal Zone Management Act
 - o Toxic Substances Control Act
 - o Federal Insecticide, Fungicide, and Rodenticide Act
 - o Wild and Scenic Rivers Act
 - o Clean Air Act
 - o South Carolina Pollution Control Act
 - o State Primary Drinking Water Regulations
 - o Resource Conservation and Recovery Act
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TABLE 3-2
GROUNDWATER TARGET CLEANUP LEVELS

VOLATILES

<u>COMPOUND</u>	<u>TARGET CLEANUP LEVELS (PPM)</u>	<u>NO. OF LOCATIONS EXCEEDING TCL/ NO. OF SAMPLES</u>
Carbon Tetrachloride	5.00E-03 ^a	6/23
Acetone	1.10E+00 ^d	1/23
Chloroform	2.09E-02 ^c	5/23
Benzene	5.00E-03 ^a	2/23
1,1,1-Trichloroethane	2.00E-01 ^a	1/23
Methylene Chloride	1.70E-02 ^c	2/23
1,1-Dichloroethane	5.00E-03 ^a	5/23
1,1-Dichloroethene	7.00E-03 ^a	3/23
1,2-Dichloropropane	5.00E-03 ^a	1/23
2-Butanone	5.50E-01 ^d	1/23
1,1,2-Trichloroethane	2.20E-03 ^c	2/23
Trichlorethene	5.00E-03 ^a	5/23
1,1,2,2-Tetrachloroethane	6.00E-04 ^c	6/23
Ethylbenzene	7.00E-01 ^a	0/23
1,2-Dichloroethane	5.00E-03 ^a	3/23
4-Methyl-2-Pentanone	5.50E-01 ^d	0/23
Toluene	2.00E+00 ^a	0/23
Chlorobenzene	1.00E-01 ^a	0/23
Tetrachlorethene	5.00E-03 ^a	5/23
1,2-Dichloroethene	7.00E-02 ^a	3/23
Total Xylenes	1.00E+01 ^a	0/23
2-Chlorophenol	5.50E-02 ^d	0/23

METALS

Iron	3.00E-01 ^e	16/23
Manganese	5.00E-02 ^e	18/23
Barium	1.00E+00 ^a	2/23
Cadmium	5.00E-03 ^a	2/23
Chromium	5.00E-02 ^a	3/23
Copper	1.00E+00 ^e	0/23
Zinc	5.00E+00 ^e	0/23
Lead	5.00E-03 ^a	3/23
Arsenic	5.00E-02 ^a	0/23
Selenium	1.00E-02 ^a	0/23
Mercury	2.00E-03 ^a	0/23

^aSWDA, MCLs, proposed MCLS.

^cDerived from CPF and exposure model.

^dDerived from RFD and exposure model.

^eSouth Carolina MCL's for Class GB groundwater.

TABLE 3-3
SOIL TARGET CLEANUP LEVELS

<u>COMPOUND</u>	<u>TARGET CLEANUP LEVEL-PPM</u>	<u>NO. OF LOCATIONS > TCL NO. OF SAMPLE LOCATIONS</u>
Carbon Tetrachloride	5.30E-02	1/71
Acetone	1.10E+00 ^a	14/71
Chloroform	2.10E-02	5/71
1,1,1,-Trichloroethane	1.03E+00	2/71
Methylene Chloride	1.70E-02 ^a	20/71
1,1-Dichloroethane	6.00E-03	3/71
2-Butanone (MEK)	5.50E-02 ^a	3/71
Trichloroethene	1.80E-02	8/71
1,1,2,2-Tetrachloroethane	1.00E-03	9/71
Ethylbenzene	2.23E+01	0/71
4-Methyl-2-Pentanone	5.50E-01 ^a	0/71
Toluene	1.74E+01	2/71
Chlorobenzene	9.56E-01	2/71
Tetrachloroethene	5.30E-02	9/71
1,2-Dichloroethene	1.20E-01	0/71
Total Xylenes	6.95E+01	0/71
Vinyl Chloride	3.00E-03	1/71
1,1-Dichloroethene	1.30E-02	3/71
Benzene	1.20E-02	1/71
1,2-Dichloroethane	5.00E-03	2/71
2-Chlorophenol	5.50E-01	3/71
Phenol	3.95E+00	4/71
1,1,2 Trichloroethane	1.00E-03	1/71

^aGround Water Target Cleanup Level.

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TABLE 3-4
WET LAGOON SEDIMENT TARGET CLEANUP LEVELS

VOLATILES

<u>COMPOUND</u>	<u>TARGET CLEANUP LEVEL PPM</u>	<u>LOCATIONS > TCL</u>
Methylene Chloride	1.70E-02 ^a	2
Acetone	1.10E+00 ^a	0
Toluene	1.74E+01	0

SEMI-VOLATILES

<u>COMPOUND</u>	<u>TARGET CLEANUP LEVEL-PPM</u>	<u>LOCATIONS > TCL</u>
Phenol	3.95E+00	0

^aGround Water Target Cleanup Levels.

Table 3-5
Action-Specific ARARs for Soil and Groundwater Treatment
Bluff Road - SCDI

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ARARS	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN ARARS
A. COMMON TO ALL ALTERNATIVES:			
OSHA-General Industry Standards (29CFR 1910)	Applicable	These regulations specify the 8-hour time-weighted average concentration for worker exposure to various organic compounds. Training requirements for workers at hazardous waste operations are specified in 29 CFR 1910.120.	Proper respiratory equipment will be worn if it is not possible to maintain the work atmosphere below these concentrations.
OSHA-Safety and Health Standards (29CFR 1926)	Applicable	This regulation specifies the type of safety equipment and procedures to be followed during site remediation.	All appropriate safety equipment will be on-site and appropriate procedures will be followed during treatment activities.
OSHA-Record keeping, reporting and Related Regulations, (29 CFR 1904)	Applicable	This regulation outlines the record keeping and reporting requirements for an employer under OSHA.	These regulations apply to the company(s) contracted to install, operate, and maintain the treatment site.
RCRA-Standards for Owners/Operators of Permitted Hazardous Waste Facilities (40 CFR 264.10-264.18)	Relevant & Appropriate	General facility requirements outline general waste analysis, security measures, inspections and training requirements.	Facility will be designed, constructed, and operated in accordance with this requirement. All workers will be properly trained.
RCRA-Preparedness and Prevention (40 CFR 264.30-264.31)	Relevant & Appropriate	This regulation outlines the requirements for safety equipment and spill control.	Safety and communication equipment will be installed at the site. Local authorities will be familiarized with the site.
RCRA-Contingency Plan and Emergency Procedures (40 CFR 264.50-264.56)	Relevant & Appropriate	This regulation outlines the requirements for emergency procedures to be used following explosions, fires, etc.	Plans will be developed and implemented during remedial design. Copies of the plan will be kept on-site.
RCRA-Closure and Post-Closure (40 CFR 264.110-264.120)	Relevant & Appropriate	The regulations details specific requirements for closure and post-closure of hazardous waste facilities.	Since groundwater will be cleaned to drinking water standards, post-closure standards will be met.
<u>Waste Transportation:</u>			
DOT Rules for Transportation of Hazardous Materials (49 CFR Parts 107, 171.1-172.558)	Applicable	This regulation outlines procedures for the packaging, labeling, manifesting, and transporting of hazardous materials.	This regulation will be applicable to any company contracted to transport hazardous material from the site.

Table 3-5 (continued)

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ARARS	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN ARARS
<u>Waste Transportation (Cont'd):</u>			
Standards Applicable to Transporters of Hazardous Waste-RCRA Section 3003, (40 CFR 262 and 263, 40 CFR 170 to 179)	Applicable	Establishes the responsibility of off-site transporters of hazardous waste in the handling transportation, and management of the waste. Requires a manifest, recordkeeping, and immediate action in the event of a discharge of hazardous waste.	This regulation will be applicable to any company contracted to transport hazardous material from the site.
<u>Disposal:</u>			
RCRA Land Disposal Restrictions (40 CFR 268, Subpart D)	Relevant & Appropriate	Since November 8, 1988, movement of excavated materials to new location and placement in or on land triggers land disposal restrictions.	Any regulated contaminants found in soils excavated will be properly disposed or treated as required by the regulations.
EPA Administered Permit Program: The Hazardous Waste Permit Program RCRA Section 3005, 40 CFR 270, 124	Applicable	Covers the basic permitting, application, monitoring and reporting requirements for off-site hazardous waste management facilities.	Any off-site facility accepting hazardous waste from the site must be properly permitted. Implementation of the alternative will include consideration of requirements.
B. SOIL TREATMENT:			
<u>Excavation:</u>			
40 CFR 262: RCRA	Applicable	Establishes standards for generators of hazardous wastes including waste determination, manifests, and pre-transport requirements.	This regulation will be applicable upon excavation and on-site storage of site wastes.
<u>Clean Closure:</u>			
RCRA-General Standards (40 CFR 264.111)	Relevant & Appropriate	General performance standard requires minimization of need for further maintenance and control; minimization or elimination of post-closure escape of hazardous waste, hazardous constituents, leachate, contaminated runoff, or hazardous waste decomposition products. Also requires disposal or decontamination of equipment, structures, and soils.	Proper design considerations will be implemented to minimize the need for future maintenance. Decontamination facility will be included.

Table 3-5 (continued)

ARARS	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN ARARS
<u>Thermal Treatment:</u>			
40 CFR 60.52: NSPS	Applicable	Provides particulate emission limits for incinerators.	Particulate emission limits should be specified for compliance.
40 CFR 264: Subpart O	Applicable	Provides performance standards for hazardous waste incinerators.	Performance standards should be specified for compliance.
40 CFR 264.341-345	Applicable	Provides performance standards and closure requirements for incinerator design and operation for destruction on POHC, and limits emissions of HCl, particulates, and carbon monoxide.	Proper designs will be implemented to meet these requirements.
40 CFR 264.347	Applicable	Provides monitoring and inspection requirements while incinerating waste.	These requirements will be included to meet these regulations.
40 CFR 264. 351	Applicable	Provides requirements for disposal of incinerated ash, scrubber waste, and scrubber sludge.	These requirements will be included to meet these regulations.
CAA-NAAQS (40 CFR 1-99)	Applicable	Applies to major stationary sources such as treatment units that have the potential to emit significant amounts of pollutants such as NO _x , SO ₂ , CO, lead, mercury and particulates (more than 250 tons/year). Regulations under CAA do not specifically regulate emissions from hazardous waste incinerators, but it is likely that Prevention of Significant Deterioration (PSD) provisions would apply to an on-site treatment facility.	The treatment system will be designed to meet these emission limits. PSD procedure was not included in this phase of FS.
Interim RCRA/CERCLA Guidance on Non-Contiguous Sites and On-Site Management of Waste and Treated Residue (USEPA Policy Statement, March 27, 1986)	To be Considered	If a treatment or storage unit is to be constructed for on-site remedial action, there should be a clear intent to dismantle, remove, or close the unit after the CERCLA action is completed.	Only properly permitted facilities will be considered for disposal of hazardous materials.

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Table 3-5 (continued)

ARARS	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN ARARS
CAA-NAAQS for Particulate Matter Less Than 10 Microns in Diameter (40 CFR Part 60, Appendix J)	Relevant & Appropriate	This regulation specifies maximum annual arithmetic mean and maximum 24-hour	Equipment will be designed to meet these requirements.
C. GROUNDWATER TREATMENT:			
<u>Discharge of Treated Groundwater:</u> 40 CFR 122.41 and 44	Relevant & Appropriate	Requires use of best available technology (BAT) to control toxic and nonconventional pollutants; use of best conventional pollutant control technology (BCT) for conventional pollutants. Technology-based limitations may be determined on a case-by-case basis.	The water treatment system will be designed, constructed, and operated to ensure that all discharge effluents are in compliance with the NPDES requirements.
South Carolina Pollution Control Act	Relevant & Appropriate	Provides requirements for discharges to the waters of South Carolina	The water treatment will be designed, constructed, and operated to ensure that all discharge effluents are in compliance with these requirements.
Ambient Water Quality Criteria	To Be Considered	Provides requirements for discharges to streams which are protective of aquatic life	Same as above.
40 CFR 144.12, 144.13, 144.16, 144.28, 144.51, 144.55	Relevant & Appropriate	Provides criteria for injection of treated water	Treated water will be analyzed to meet these criteria.
40 CFR 147	Relevant & Appropriate	Provides requirements to comply with State underground injection regulations.	Proper design of injection system will be implemented to these regulations.
South Carolina Underground Injection Regulations	Applicable	Provides underground injection standards in South Carolina	Same as above.

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Table 3-5 (continued)

ARARS	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN ARARS
<u>Air Emissions</u>			
NESHAP (40 CFR 61)	Applicable	Provides emission standards for hazardous air pollutants such as beryllium, mercury, vinyl chloride, benzene, arsenic, and lead.	Proper designs on air emissions controls will be implemented to these regulations.
NAAQS (40 CFR 50)	Applicable	Provides air quality standards for particulates lead and ozone.	Same as above.
PSD (40 CFR 51, 2)	Applicable	New major stationary sources may be subject to PSD review, i.e., require best available control technology (BACT), lowest achievable emission limit (LAEL), and/or emission offsets.	PSD procedures have not been included in this FS but could be expanded to BACT and LAER evaluations.
South Carolina Pollution Control Act	Applicable	Provides air quality standards for emissions in South Carolina	Proper designs on air emissions controls will be implemented to these regulations.

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**Table 3-6 Other Federal and State Criteria, Advisories
and Guidance, To-Be-Considered (TBC)**

REQUIREMENTS	RATIONALE
1. Health Advisories, EPA Office of Drinking Water	RI Activities identified presence of chemicals for which health advisories are listed
2. Reference Doses (R _f Ds), EPA Office of Research and Development	Considered in the public health evaluation
3. Health Effects Assessments	Considered in the public health evaluation
4. Carcinogenic Potency Factors, EPA Environmental Criteria and Assessment Office, EPA Carcinogen Assessment Group	Considered in the public health evaluation
5. U.S. Environmental Protection Agency Exposure Factors Handbook, 1989	Considered in the public health evaluation
6. Agency for Toxic Substances and Disease Registry, Toxicological Profiles	Considered in the public health evaluation
7. U.S. Environmental Protection Agency Risk Assessment Guidance for Superfund Human Health Manual Part A, Interim Final, 1989b	Considered in the public health evaluation
8. CERCLA Compliance With Other Laws Manual, 1988a	Considered in the public health evaluation

SECTION 4.0
IDENTIFICATION AND PRELIMINARY SCREENING
OF REMEDIAL ALTERNATIVES

4.1 General

This section of the Feasibility Study presents the methodology used to identify potential remedial alternatives for ground water and soil at CERCLA sites. This section also presents a brief description of each alternative, and screens and eliminates those technologies which are not applicable for the remediation of ground water or soils at the Bluff Road Site. Process options considered are shown on Table 4-1.

4.2 Identification of Ground-water Remediation Alternatives

The ground water remediation alternative identification process involved a review of available literature including the US EPA documents "Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA, Interim Final", "Guidance on Remedial Action for Contaminated Ground Water at Superfund Sites", and "Handbook for Evaluating Remedial Action Technology Plans". These documents were reviewed to identify alternatives that are potentially applicable for ground water remediation. Based on a review of the literature, the following list of potential remedial alternatives for ground water was developed:

No Action Alternative

Containment Alternatives

- o Capping
- o Slurry Walls
- o Horizontal Bottom Sealing

Treatment Alternatives

- o Activated Carbon Adsorption
- o Air Stripping
- o Steam Stripping

- o Biological Degradation
- o Ion Exchange
- o Neutralization
- o Precipitation/Flocculation
- o In-situ Biological Degradation

Each of the treatment alternatives (except in-situ biological degradation) would require the installation of a ground water collection system which may consist of extraction wells and/or interceptor trenches. Extraction wells would consist of a series of wells installed in the area of the ground water plume. Pumps would be used to draw ground water from the wells and into the treatment system. Interceptor trenches would consist of excavated trenches downgradient of the ground water contaminant plume. Perforated piping would be placed in the trench, and the trench would be backfilled with select permeable materials in order to drawdown ground water into the perforated pipe. Collected ground water would be pumped from a collection sump into the treatment system. Due to the depth of ground water contamination in the upper aquifer (approximately 50 feet below grade) the installation of interceptor trenches is not technically practical. Therefore, the method of ground water withdrawal for the treatment alternatives would consist of a series of extraction wells.

The treatment alternatives involve the discharge of treated ground water. The potential discharge location for treated ground water will not be considered during the preliminary screening of alternatives. Discharge location for the treatment alternatives retained for further evaluation (if any) will be addressed during the detailed analysis of remedial alternatives presented in Section 5.

4.3 Preliminary Screening of Ground-water Remediation Alternatives

This subsection presents the preliminary screening of the potential ground water remediation alternatives identified above. Each alternative will be screened based on the alternatives anticipated effectiveness and implementability. The effectiveness of a remedial alternative refers to the degree to which the alternative reduces toxicity, mobility, or volume of the contaminants and the degree to which an alternative provides adequate protection of human health and the environment. The implementability of the remedial alternative refers to the technical feasibility (ability to construct and reliably operate) and availability of the remedial alternative. A brief description of each ground water remediation alternative, the anticipated effectiveness and implementability of each alternative, and the reasons for either excluding the alternative or retaining it for further evaluation are presented below.

4.3.1 No-Action Alternative

Technical Description

The no action alternative means that the current interaction between the site and the surrounding environment will be allowed to continue and remedial actions for the ground water contaminant plume would not be implemented. As a result, the ground water contaminant plume may migrate vertically impacting the deep aquifer. Under the no action alternative, institutional controls such as site fencing (currently installed around the accessible perimeter of the site) and deed restrictions (e.g. preventing the usage of ground water near the site) would be enacted. In addition, the ground water contaminant plume would be monitored to determine if migration (vertical and horizontal) of the ground water plume has occurred.

Effectiveness

The no-action alternative would not reduce the toxicity, mobility, or volume of the site contaminants and thereby may not provide adequate protection of human health and the environment.

Implementability

The no-action alternative is readily implementable.

Screening Conclusion

The National Oil and Hazardous Substances Contingency Plan suggests that the no action alternative be considered during the Feasibility Study process. Therefore, the no action alternative will be retained for further evaluation during the detailed analysis of alternatives. In addition, the no-action alternative will serve as a baseline for comparing the effectiveness of other remedial alternatives.

4.3.2 Containment Alternatives

The following containment alternatives for ground water would also address the site soils, therefore, the containment alternatives presented below are not included in the screening process for site soils.

4.3.2.1 CappingTechnical Description

The capping alternative involves the construction of an impermeable cap over the area of the contaminated soils as source control. The cap would be constructed as a Resource Conservation and Recovery Act (RCRA) cap and would be designed

and constructed in accordance with the RCRA cap requirements in 40 CFR. 264

The cap would prevent precipitation from infiltrating through the contaminated site soils, thereby reducing the leaching of soil contaminants into the ground water contaminant plume.

Effectiveness

The capping alternative would reduce the mobility of the soil contaminants by preventing the infiltration of surface water. This alternative would not reduce the toxicity or volume of the soil contaminants.

Implementation

The capping alternative is technically feasible and has been previously employed at other sites.

Screening Conclusions

The capping alternative although implementable, will not be effective at reducing the volume or toxicity of the site contaminants. This alternative will not be retained for further evaluation.

4.3.2.2 Slurry Walls

Technical Description

This alternative involves the construction of slurry walls encompassing the ground water contaminant plume (including the site soils). The slurry walls would control the horizontal migration of the ground water contaminant plume.

Slurry walls are constructed as vertical trenches that are excavated under a slurry. The slurry hydraulically shores the trench to prevent collapse while forming a filter cake on the trench wall to minimize fluid losses into the surrounding soils. The slurry is left in the trench and allowed to set up to form the completed barrier. Slurry walls must be keyed into an impervious lower stratum.

Consideration for the various slurry wall configurations are generally site specific. Downgradient walls would not be effective without dewatering. Upgradient walls require suitable site topography. Circumferential walls offer the most extensive control of contaminant migration but are the most expensive. Parameters influencing performance of the slurry walls include permeability, compatibility with the wastes, and construction difficulties.

Effectiveness

This alternative would be effective at reducing the horizontal mobility of the ground water plume. However, the slurry wall alternative would not reduce the toxicity or volume of the ground water contaminant plume.

Implementability

There are substantial implementability considerations with respect to installation of a slurry wall at the Bluff Road site. The drainage is extremely poor and standing water frequently covers much of the site. Special construction equipment and dewatering techniques would be required. Subsurface geology (flowing sands and inadequate thickness of lower stratum) could further complicate installation of slurry walls and reduce the effectiveness of slurry walls. These two

major difficulties would substantially increase the complexity of installing slurry walls at the site.

Screening Conclusion

Because of the implementability concerns with slurry walls at the Bluff Road site, slurry walls would not be a reliable, effective containment action for the ground water contaminant plume. Therefore, this alternative has been screened out.

4.3.2.3 Horizontal Bottom Sealing

Technical Description

Horizontal bottom sealing involves the injection or insertion of an inert, impermeable, and continuous horizontal barrier in soil beneath the source of contamination. This type of containment strategy could be used at hazardous waste sites in conjunction with other technologies (such as capping and slurry walls) to ensure that the contaminants do not move into surrounding soil or ground water. Two methods for placing inert impermeable materials in the subsurface are injection grouting and jet grouting. In injection grouting, grout is pumped directly into the soil. Jet grouting uses water to excavate the soils. Cuttings are pumped to the surface, and water pressure is maintained to prevent collapse of the cavity. The effectiveness of these technologies is very difficult to predict because it is nearly impossible to verify that voids do not exist after injection.

Effectiveness

This alternative may be effective at controlling the vertical migration of the ground water contaminant plume. However, this alternative would not reduce the toxicity or volume of the ground water contaminant plume.

Implementability

This alternative may not be implementable (technically feasible) due to the unknowns associated with the construction of this alternative (i.e., voids may exist in the barrier after construction).

Screening Conclusion

The horizontal bottom sealing alternative may not be technically feasible due to the inability to determine the effectiveness of this alternative. Therefore, this alternative is screened out.

4.3.3 Treatment Alternatives

Presented below is the preliminary screening for the identified ground water treatment alternatives.

4.3.3.1 Activated Carbon AdsorptionTechnical Description

This alternative involves pumping ground water to a carbon adsorption system where the ground water passes through activated carbon, a porous material having high adsorption capacity for organic compounds present in the ground water. The water to be treated is contacted with the activated carbon in a series of packed bed columns. When the adsorption capacity of the activated carbon is exhausted, the spent carbon must be disposed of and replaced or be regenerated. To extend the adsorption capacity of the carbon bed, the bed can periodically be backwashed to minimize clogging due to solids accumulation in the activated bed.

Effectiveness

The carbon adsorption alternative is most effective at removing low-solubility, nonpolar organic compounds from water. The contaminants of concern in the ground water contaminant plume will most likely be removed by carbon adsorption. However, bench scale testing of carbon adsorption is required to determine the removal percentage for the various organic compounds present in the Bluff Road Site ground water. This alternative may be effective at reducing the mobility, toxicity, and volume of the contaminants present in the ground water contaminant plume.

Implementability

This alternative is technically feasible and can be readily constructed at the Bluff Road Site.

Screening Conclusion

Due to the anticipated effectiveness of this alternative, the carbon adsorption alternative will be retained for further evaluation.

4.3.3.2 Air Stripping

Technical Description

Air stripping is a mass transfer process in which volatile organics in water are transferred to air. The mass transfer is controlled by the equilibrium partitioning of the compound between water and air as represented by the Henry's Law constant for that compound. It can be used in conjunction with other processes, such as activated carbon or biological treatment. Although several types of air strippers are available (e.g., spray columns and surface aerators), packed

towers offer the best removal efficiencies and the most cost-effective operation. A vaporphase pollution control (carbon adsorption) unit may be required to reduce emissions of the stripped organic vapors to the atmosphere .

Effectiveness

This alternative would be effective at reducing the mobility, toxicity, and volume of the contaminants present in the ground water plume by reducing the concentrations of the contaminants in the ground water.

Implementability

This alternative is technically feasible and can be readily constructed at the Bluff Road Site.

Screening Conclusion

Due to the anticipated effectiveness of this alternative, air stripping will be retained for further evaluation.

4.3.3.3 Steam Stripping

Technical Description

Steam stripping is used to remove organic compounds or solvents that are contained in wastewater at dilute concentrations. Steam stripping is typically economical only when the contaminants are at least four times more volatile than water, are water soluble, and are not removed by air stripping.

If control of air emissions is required, steam stripping may allow the organics to be removed from water and discharged as

a liquid phase. However, this method generates a concentrated organic stream that will require further treatment before discharge.

Effectiveness

A majority of the contaminants in the Bluff Road Site ground-water plume are chlorinated solvents and are easily removed by air stripping. No advantage will be achieved by steam stripping for this application as compared to air stripping.

Implementability

This alternative is technically feasible but would require steam at the site.

Screening Conclusion

This alternative would offer no advantage when compared to the air stripping alternative for reducing the mobility, toxicity, or volume of the ground water contaminants and therefore is screened out.

4.3.3.4 Biological Degradation

Technical Description

Biological degradation systems remove organics from water through the metabolic processes of microorganisms. The microorganisms utilize the organics as an energy source converting them into carbon dioxide and more biomass.

In conventional aerobic treatment, extracted ground water flows into an aeration tank where it is mixed with bacterial biomass and aerated for several hours. The biomass is then

removed from the wastewater by gravity sedimentation in a clarifier. The biomass is recycled back to the aeration basin. A portion of the biomass is wasted by drawing off from the recycle line. Ground water must contain enough substrate (organic carbon) to support a viable biomass.

Although many chemicals are biodegradable, chlorinated compounds may be toxic to the biomass or resistant to biodegradation.

Effectiveness

The chlorinated solvent compounds present in the ground water plume could be toxic to the microorganisms used in this treatment process and therefore would render this process ineffective.

Implementability

This alternative is technically feasible and can be readily implemented at the Bluff Road Site.

Screening Conclusion

Due to the ineffectiveness of biodegradation at treating the ground water plume contaminants, this alternative is screened out.

4.3.3.5 Ion Exchange

Technical Description

Ion exchange is a process in which dissolved ions, usually metals, can be removed from a water stream and substituted with ions from the surface of an insoluble solid (resin) with

which the solution is contacted. Most exchange materials are synthetic compounds that contain functional groups with exchangeable ions attached. The exchange reaction is reversible, thereby allowing for regeneration of the exchange material. Sorptive resins are also available that can remove organics by a sorptive action with no exchange.

Ion exchange is normally used to remove low levels of ionic species [generally between 0.1 and 500 parts per million (ppm)] and is not cost effective at higher concentrations. Treatment with ion exchange is typically used when very low effluent concentrations are required and when other technologies are not applicable.

Effectiveness

The ion exchange alternative is effective at removing dissolved ionic species (Metals) from water but is not effective at removing organic compounds from water.

Implementability

This alternative is technically feasible and could be implemented at the Bluff Road Site.

Screening Conclusion

The ion exchange alternative would not be effective at removing the organic compounds present in the Bluff Road Site ground water plume, therefore, this alternative is screened out.

4.3.3.6 Neutralization

Technical Description

Neutralization is the addition of acid or base to a wastewater for pH adjustment. It is often performed before biological treatment, carbon adsorption, ion exchange, air stripping, or oxidation/reduction process and can be used before any treatment in which pH is critical to operation.

Neutralization of hazardous wastes can produce toxic compounds, such as the evolution of hydrogen sulfide from the acidification of sulfide-containing wastes.

Effectiveness

Neutralization of the ground water contaminant plume at the Bluff Road Site would not be effective in reducing the mobility, toxicity, or volume of the site ground water contaminants since neutralization would have no effect on organic constituents.

Implementability

This alternative is technically feasible and could be readily implemented.

Screening Conclusion

The neutralization alternative would not be effective for organic constituents in the ground water and is therefore screened out.

4.3.3.7 Precipitation/Flocculation

Technical Description

Metals can be precipitated from a wastewater by adding chemicals that react with the metals to form low solubility solids. Caustic soda, lime, and sulfides are commonly used in

precipitation reactions. The insoluble compounds precipitated can be removed from the wastewater by flocculation, clarification, and filtration. Ferric chloride, alum, or organic polymers are typically used for flocculation.

Effectiveness

This alternative would not be effective at reducing the mobility, toxicity, or volume of the organic compounds present in the Bluff Road Site ground water plume.

Implementability

This alternative is technically feasible and could be implemented at the Bluff Road Site.

Screening Conclusion

The precipitation/flocculation is screened out as a stand-alone option because it would not be effective at reducing the mobility, toxicity, or volume of the organic compounds present in the ground water plume.

Precipitation/Flocculation will be retained as a potential pretreatment step during design of the final water treatment alternative due to high iron concentrations in site ground water.

4.3.4 In-Situ Biological Degradation

Technical Description

In situ biodegradation enhances the naturally occurring microbial activities found in subsurface aquifers. Breakdown and removal of contaminants can sometimes be accelerated by the addition of oxygen, inorganic nutrients, and prepared microbial populations to the contaminated aquifer by injection wells.

Effectiveness

This alternative would not significantly reduce the mobility, toxicity, or volume of the ground water contaminants because of its limited effectiveness. The chlorinated solvent compounds present in the ground water plume could be toxic to microbial populations rendering this alternative ineffective.

Implementability

This alternative is technically feasible and could be implemented at the Bluff Road Site.

Screening Conclusion

Due to the probable ineffectiveness of in-situ biodegradation at treating chlorinated compounds, this alternative is screened out.

4.4. Identification of Soil Remediation Alternatives

The soil remediation alternative identification process involved a review of available literature including the USEPA documents "Guidance for Conducting Remedial Investigation and Feasibility Studies Under CERCLA, Interim Final", "Technology Screening Guide for Treatment of CERCLA Soils and Sludges", and "Handbook for Evaluating Remedial Action Technology Plans". These documents were reviewed to identify alternatives that are potentially applicable for soil remediation. Based on a review of the literature, the following list of potential remedial alternatives for soil was developed:

No Action Alternative

In-Situ Treatment Alternatives

- o In-situ Soil Flushing
- o In-Situ Biodegradation
- o In-Situ Soil Venting

Treatment Alternatives

- o Stabilization
- o On-site Soil Farming (surface biological degradation)
- o On-site Incineration
- o On-site Thermal Desorption

Removal Alternatives

- o Soil Excavation and Disposal On-site
- o Soil Excavation and Disposal Off-site
- o Soil Excavation and Off-site Thermal Treatment

Most of the soil remediation alternatives presented above (except the no action alternative and the in-situ treatment alternatives) involve the excavation of the site soils. Control of dust and organic vapors during excavation would be necessary to adequately protect human health and the environment. Excavated soils must be placed in a secure holding area before treatment.

4.5 Preliminary Screening of Soil Remediation Alternatives

This subsection presents the preliminary screening of the potential remediation alternatives identified above. Each alternative will be screened based on the alternatives anticipated effectiveness and implementability. The effectiveness of a remedial alternative refers to the degree to which the alternative reduces mobility, toxicity, or volume of the contaminants and the degree to which an alternative provides adequate protection of human health and the environment. The implementability of a remedial alternative refers to the technical feasibility (ability to construct and reliably operate) and availability of the remedial alternative. A brief description of each soil remediation

alternative, the anticipated effectiveness and implementability of each alternative, and the reasons for either excluding the alternative or retaining it for further evaluation are presented below.

4.5.1 No Action Alternative

Technical Description

The no action alternative means that the site soils would remain in-place and no active remediation of the soils would occur. During the no action alternative, the contaminants in the site soils would continue to interact with the ground water plume (through leaching). Under the no action alternative institutional control such as site fencing (currently installed around the accessible perimeter of the site) and deed restrictions (to prevent the future use of the site) would be enacted.

Effectiveness

The no action alternative would not reduce the mobility, toxicity, or volume of the soil contaminants present at the Bluff Road Site.

Implementability

The no action alternative is readily implementable.

Screening Conclusion

The National Oil and Hazardous Substances Contingency Plan suggests that the no action alternative be considered during the Feasibility Study process. Therefore, the no action alternative will be retained for further evaluation during the detailed analysis of alternatives. In addition, the no action

alternative will serve as a baseline for comparing the effectiveness of other remedial alternatives.

4.5.2 In-Situ Treatment Alternatives

4.5.2.1 In-Situ Soil Flushing

Technical Description

Soil flushing is the application of an aqueous solution to contaminated soils and collection of the leachate at well points for treatment of specialized waste constituents. Once the flushing solution has been recovered, it must be treated before the leachate can be discharged or recycled to the flushing system. Potential flushing solutions include acids, complexing/chelating agents, surfactants, and water. Complexing/chelating agents and weak acids are mainly effective in the mobilization of heavy metals but not organics, which are the primary contaminants in the soil.

Optimum placement of a recharge basin and/or injection wells, along with extraction wells, is critical for the successful mobilization and subsequent collection of contaminants. Mobilized contaminants that are not recovered can increase the environmental risk at a site. Detailed knowledge of the local hydrogeology is required. Soil characteristics are also important. Generally, soils with a permeability less than 10^{-4} centimeter/second are not readily remediated by soil flushing. Variable permeability in the soil bed can create short circuiting and increase the volumes of water required.

Effectiveness

The on-site vadose zone soils have estimated permeabilities between 10^{-4} and 10^{-5} centimeter/second. In off-site areas hydraulic permeabilities are between 10^{-5} and 10^{-8}

centimeters/seconds. Permeabilities above 10^{-4} centimeter/second are generally required for effective soil flushing. The RI report also describes layers of clay/silt material that cut through the vadose zone soils. These layers result in variable hydraulic permeabilities and would make uniform soil flushing and collection of leachate very difficult, therefore limiting the effectiveness of this alternative.

Implementability

This alternative is readily implementable.

Screening Conclusion

The in-situ soil flushing alternative may not be effective at reducing the mobility, toxicity, or volume of the soil contaminants. Therefore, this alternative is screened out.

4.5.2.2 In-Situ Biodegradation

Technical Description

In situ biodegradation enhances the naturally occurring microbial activities found in subsurface soils. Breakdown and removal of contaminants can be accelerated by the addition of oxygen, inorganic nutrients, and prepared microbial populations. This technology has been developing rapidly and is one of the most promising in situ treatment techniques. General limitations of in situ biodegradation include transport of nutrients to the distal points of contamination, the sorption and solubility of the contaminants, and toxic inhibition. Treatment times would take longer than excavation actions. Overdosing of nutrients can form precipitates and limit transport by clogging the soils and bedrock fractures. The variability of pH and chloride in the ground water will

also limit the effectiveness of metabolic activity. This should not be a problem at this site.

Most of the contaminants of concern at Bluff Road are chlorinated solvents which have not yet been successfully treated (reduction of mobility, toxicity, or volume) by in-situ biodegradation.

Implementability

This alternative could be implemented at the Bluff Road Site.

Screening Conclusion

In-situ biodegradation would not reduce the mobility, toxicity, or volume of the organic compounds present in the site soils and is therefore screened out.

4.5.2.3 In-Situ Soil Venting

In situ soil venting involves the removal of volatile organics from the soil matrix by mechanically drawing or venting air through the vadose zone soils. In its simplest form, soil venting consists of extraction of soil vapor through a series of vertical slotted pipe wells. A vacuum pump or blower is used to pull air through the soils and out the extraction wells. Air injection wells have been successfully used to control air flow patterns. Push/pull blower systems have been used with injection/extraction wells. The most common practices of soil venting includes extraction wells connected to a vacuum blower and may include a temporary cover (plastic sheet) of surface soil. Contaminated air may require further treatment before it is vented to the atmosphere. Control variables include the injection air temperature, air flow rate, extraction well spacing, diameter and slot interval, and duration of treatment.

Soil parameters of interest include the permeability, porosity, moisture, and soil "horizons". The presence of soil horizons can lead to short circuiting and isolate areas of contamination from stripping. This is easily addressed as a design consideration. Chemical parameters of interest include vapor pressure, octanol-water partitioning coefficient, and solubility.

Soil venting has been demonstrated (EPA SITES PROGRAM 1989) in high moisture soils with hydraulic permeability as low as 10^{-8} cm/s. Moisture content and low hydraulic permeability are not barriers to soil venting. The process actually reduces soil moisture content and, with a temporary plastic cover to prevent further infiltration, the potential impact of moisture can be further reduced. In addition, soil venting has proven effective in stripping compounds from the upper portions of contaminated aquifers and from perched zones. Remediation of semi-volatiles would also be accomplished by a combination of vapor-phase extraction in conjunction with the enhanced bio-degradation resulting from the creation of subsurface aerobic conditions and reduction of soil toxicity.

As evidenced by the RI and previous Golder soil borings, site specific conditions in the areas delineated for potential soil remediation are not similar to off-site areas with respect to specific soil types, surficial clay layer (wetlands), capillary fringe and moisture. Elevations of areas targeted for potential soil venting are typically 3 to 5 feet above off-site areas observed to have a surficial clay layer which results in standing water. On-site borings do not indicate saturated conditions extending above the shallow aquifer water table and soil types were determined to be sandy with some silt and are therefore amenable to soil venting.

Effectiveness

Soil venting has been shown to be an effective method for the in-place removal of organics from soils.

Implementability

This alternative is technically feasible and has been implemented at other sites.

Screening Conclusion

The soil venting alternative will be retained for further analysis.

4.5.3 Treatment Alternatives

4.5.3.1 Stabilization

Technical Description

Cementitious or silicate-based additives can frequently be used to reduce the leaching of contaminants from soils or sludges. The stabilization chemicals are mixed with the excavated soil in a pug mill or similar equipment. The stabilization formula is selected so that the final waste form meets the appropriate disposal requirements.

Effectiveness

Stabilization can often chemically fix metals but is typically not effective on organics, especially the volatile organics that are found in the soils at the Bluff Road site.

Stabilization would not reduce the mobility, toxicity, or volume of the contaminants present in the site soils.

Implementability

This alternative is technically feasible and has been implemented at other sites.

Screening Conclusion

Stabilization would not be effective at reducing the mobility, toxicity, or volume of the soil contaminants present at the Bluff Road Site and is therefore screened out.

4.5.3.2 Soil Farming (Surface Biological Degradation Technical Description)

Soil farming consists of excavating contaminated soils and spreading the soils on the surface in 6- to 18-inch layers. The soils are worked by disking, and nutrients may be added to enhance natural bioactivity. Organics are both volatilized and biodegraded. Most chlorinated compounds biodegrade slowly and are primarily volatilized. Hydrocarbons and oxygenated compounds can be biodegraded. Performance of soil farming can be quite variable as it depends on climatic conditions, soil type, microbe population, and precipitation. Treatment efficiencies are not well defined, and the health risks of the release of volatile organics and fugitive dusts must be considered.

Effectiveness

Because the soil contaminants at the site are chlorinated solvents that degrade only under optimum conditions, the main removal mechanism using soil farming would be volatilization. Soil venting is a more favorable volatilization technology because no excavation is required.

Implementability

Soil farming is technically feasible and has been implemented at other sites.

Screening Conclusion

Soil farming is screened out because other more favorable volatilization technologies exist.

4.5.3.3 IncinerationTechnical Description

In incineration, the organics in soils are treated by thermal oxidation; this can be accomplished through direct contact with the flame (from the combustion of auxiliary fuel) or by heating. The soil is heated to a temperature of 1200 to 1500°F. At these temperatures, the organics are vaporized into the combustion gases and at least partially treated through oxidation and pyrolysis reactions. The traces of organics or products of incomplete combustion that survive the soil heating process are destroyed by additional exposure (typically 2 seconds) of the combustion products to temperatures of 1800 to 2200°F. The off-gas from the thermal destruction process is treated to remove particulates and any acid gasses that are produced by the combustion of the organics in the soil or by the combustion of the auxiliary fuel. Many types of incineration systems are available; all heat the wastes and clean up the combustion products. Each system uses different equipment or mechanical approach to accomplish this same basic process. Residual soils from incineration can either be disposed off-site or disposed on-site based on the results of analytical testing.

Effectiveness

Incineration will reduce the mobility, toxicity, and volume of the contaminants in the site soils.

Implementability

Incineration is technically feasible and has been successfully implemented at other sites.

Screening Conclusion

Incineration will be retained for further evaluation.

4.5.3.4 Thermal DesorptionTechnical Description

Thermal desorption is a relatively new technology for treating soils or sludges that are contaminated by organics. In this process, the contaminated soil is heated to a temperature (typically 400 to 600°F) sufficient to volatilize the organics adsorbed on the soils. These temperatures are not high enough to destroy most organic compounds so they must be treated further. These vapors can be treated by fume incineration, by condensation followed by off-site disposal, incineration, chemical treatment, or by carbon adsorption filtration.

Thermal desorption has been effectively demonstrated on soils contaminated with volatile organic compounds (VOCs). High temperature thermal desorption is another thermal desorption process that utilizes higher temperatures (up to 1000°F) to volatilize organics from soils and sludges. However, high temperature thermal desorption units while available commercially, have not yet been used on a full-scale soils clean-up.

Effectiveness

Thermal desorption will reduce the mobility, toxicity, and volume of the contaminants present in the soil.

Implementability

Thermal desorption is technically feasible and has been implemented at other sites.

Screening Conclusion

Thermal desorption is retained for further evaluation.

4.5.3.5 Soil WashingTechnical Description

Soil washing involves contacting excavated contaminated soils with an aqueous medium to release the contaminants into solution. Either the extracted contaminants can then be concentrated for treatment or the entire aqueous stream can be treated. Soil washing is similar to soil flushing except the process is applied to excavated soils rather than in situ. Additional safety requirements would be needed for the excavation of contaminated soils. Transfer of contaminants from the soil matrix to solution is accomplished in countercurrent extraction equipment. Good mixing is necessary for adequate mass transfer. Water alone is occasionally sufficient to release soluble organics.

Following extraction, cleansed soils must be separated from solution. Soils are typically settled, dewatered, and returned to the excavation area.

Effectiveness

Dewatering may be complicated by clays or silts, but should still be effective in reducing mobility, toxicity, and volume by removing the constituents from the contaminated soils.

Implementability

Soil washing is not a commercially applied technology.

Screening Conclusion

Soil washing is screened out because it is not commercially available.

4.5.4 Removal Alternatives4.5.4.1 Soil Excavation and Disposal On-SiteTechnical Description

This alternative would involve the excavation and stockpiling of the site soils and the construction of an on-site landfill. The on-site landfill must be designed, constructed, and operated in accordance with the EPA Regulations for Owners and Operators of Permitted Hazardous Waste Facilities in 40 CFR 264 Subpart N-Landfills. These regulations include post-closure and monitoring requirements for the landfill and surrounding environment. The stockpiled site soils would be placed in the landfill and the landfill would then be "closed". In accordance with the NCP, the soils would not have to be treated to meet the Land Disposal Restriction Regulations in RCRA.

Effectiveness

This alternative would reduce the mobility of the soil contaminants, but would not reduce the toxicity or volume of the soil contaminants.

Implementability

The Bluff Road site conditions (varying subsurface geology, ground water table near the surface) limit the technical feasibility (ability to construct and reliability operate) of this alternative.

Screening Conclusion

Due to the limited effectiveness of this alternative (only reduces contaminant mobility) and potential problems with the implementation of this alternative, the soil excavation and on-site disposal alternative is screened out.

4.5.4.2 Soil Excavation and Disposal Off-site

Technical Description

This alternative involves the excavation of the site soils and the transportation and disposal of the soils at an EPA permitted hazardous waste facility. The soils may have to be treated prior to disposal in an off-site landfill in accordance with the Land Disposal Restriction Regulations. The excavated areas would be backfilled to grade with clean fill materials.

Effectiveness

This alternative would reduce the mobility, toxicity, or volume of the contaminants in the site soils by removing the site soils for off-site disposal.

Implementability

This alternative is implementable but requires transportation to a permitted disposal facility.

Screening Conclusion

This alternative is technically feasible and is retained for further evaluation.

4.5.4.3 Soil Excavation and Off-site Thermal Treatment

Technical Description

This alternative involves the excavation of contaminated site soils with conventional construction equipment. The excavated soils would be transported off-site by a licenced hazardous waste hauler and disposed of at an EPA-permitted hazardous waste incinerator. Excavation at the site would then be backfilled with clean fill material.

Effectiveness

This alternative would be effective at reducing the mobility, toxicity, and volume of the contaminants in the soils by removing the soils for off-site treatment.

Implementability

This alternative is technically feasible. EPA permitted hazardous waste incinerators have proven effective in destroying the organic compounds present in site soils.

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Screening Conclusion

This alternative will be retained for further evaluation. A summary of the preliminary screening of the remedial alternatives is presented on Table 4-2.

Table 4-1. Remedial Alternatives for
Soil and Ground Water Contamination

Environmental Media	General Response Actions	Remedial Technology Types	Process Options
Ground Water	No action	None	None
	Implement institutional controls: Access restriction Deed restrictions		
	Containment actions: Containment Vertical barriers Horizontal barriers	Containment technologies Capping Slurry walls Horizontal bottom sealing	None
	Collection/treatment actions: Collection/treatment discharge/in situ ground water treatment	Extraction technologies: Ground water collection	Wells/pumps, subsurface drains, and interception trenches
		Treatment technologies: Physical treatment	Air stripping, carbon adsorption, ion exchange, steam stripping,
		Biological treatment	Biological degradation
		Chemical treatment	Precipitation/flocculation, neutralization
		In situ treatment	In situ bioremediation
		Disposal techniques: On-site discharge Off-site discharge	Local stream, reinjection, POTW

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Table 4-1 (continued)

Environmental Media	General Response Actions	Remedial Technology Types	Process Options
Soil ^a	No action	None	None
	Institutional controls: Access restriction Deed restrictions		
	Containment actions: Containment	Containment technologies: Capping Vertical barriers Horizontal barriers Surface controls	Multilayer Cap, slurry wall, horizontal bottom sealing
	Excavation/treatment actions: Excavation/treatment In situ treatment Disposal/excavation	Removal technologies	Excavation
		Treatment technologies: On-site physical treatment In situ treatment On-site thermal treatment Disposal technologies	Soil washing, soil farming, solidification/fixation, Soil flushing, soil venting, in situ biodegradation, Incineration, Thermal desorption Off-site disposal Off-site thermal treatment On-site disposal

^a Although the soils at the Bluff Road site do not represent a significant risk to human health, they do contain contaminants that may leach into the ground water. Therefore, general response actions for the soils will be screened based on their effectiveness at reducing the soil contaminants mobility, toxicity, volume, and Implementability.

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Table 4-2. Summary Table
Screening of Remedial Alternatives

General Response Remedial Alternatives					
Action	(Technology)	Process Option	Effectiveness	Implementability	Screening Conclusion
No action	None	Not applicable	N/A	N/A; will likely require longterm monitoring	Retained
Implement institutional controls:			Effective in limiting use of the Bluff Road Site property	Legal requirements	Retained
Containment	Cap	Multilayered cap	Effective source control technique; ineffective in reducing mobility of plume	Easily implemented restriction on future land use	Dismissed
	Vertical barriers	Slurry walls	Can be effective against horizontal migration of contaminated ground water	Difficult to verify continuity of slurry or backfill, implementation problems at site	Dismissed
	Horizontal barriers	Horizontal bottom sealing	Ineffective in reducing mobility of plume	Difficult to verify construction	Dismissed

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Table 4 (continued)

General Response		Process Option	Effectiveness	Implementability	Screening Conclusion
Action	Remedial Technology				
Soil excavation/ treatment action ^a	Physical treatment	Soil washing	Water may be effective since volatiles of concern are sufficiently soluble	Technology is not commercially available	Dismissed
		Soil farming (surface bioreclamation)	Containments may volatilize and not be treated by biodegradation	Easily implemented. Requires excavation of contaminated soils and spreading over large area with surface water control. May not conform to air release regulations for volatile compounds	Dismissed
		Stabilization	Not an effective method for organic compounds	Readily implemented by excavating and mixing soil with the additive	Dismissed
	In situ treatment	Biodegradation	Ineffective on chlorinated compounds	May require bench-scale testing	Dismissed
		Soil flushing	Effectiveness is dependent on soil uniformity and ability to capture the leachate	Would require numerous injection/extraction wells and several years of flushing; uniform flushing and leachate collection unprovable	Dismissed

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Table 4-1 (continued)

General Response					Screening
Action	Remedial Technology	Process Option	Effectiveness	Implementability	Conclusions
Soil excavation/ disposal action ^a	In situ treatment	Soil venting	Can be effective on VOCs	Readily implemented. Less permeable soils require numerous air injection wells	Retained
	Thermal treatment	On-site Incineration	Effective on organics	Transportable incinerators are available	Retained
		Thermal desorption	Effective on organics	Transportable systems are available	Retained
	Off-site disposal	Off-site disposal facility	Effective and reliable	Requires transportation and permitted facility	Retained
		Off-site thermal treatment	Effective and reliable	Requires transportation and permitted facility	Retained
		On-site landfill	Effectiveness is dependent on design, construction, and continued inspection	Difficult to implement at site	Dismissed
Ground water collection/treatment/discharge	Extraction	Extraction wells	Effectiveness can be verified by monitoring; performance is sensitive to design	Easily implemented; continued O&M required; collected water must be treated or disposed	Retained
Ground water collection/treatment/discharge	Subsurface drains	Ground-water collection drains	Effective for downgradient flow interception	Difficult to implement; requires deep trenching upper aquifer	Dismissed

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General Response					
Action	Remedial Technology	Process Option	Effectiveness	Implementability	Screening Conclusion
Ground water collection/treatment/discharge	In situ treatment	Biodegradation	Not effective on chlorinated compounds	Not easily implemented; would require numerous wells for injection	Dismissed
	On-site discharge	Reinjection	Effective and reliable	Requires hydraulic control in conjunction with pumping. Sets treatment system design criteria at target cleanup levels. Must perform testing. Implementable with adequate design.	Retained
	Off-site discharge	Local stream, river, or surface irrigation	Effective and reliable	Requires compliance with applicable water quality criteria	Retained
		Sewer line/POTW	Effective and reliable	Administratively difficult to implement. Prohibited by local ordinance.	Dismissed

^aAlthough the soils at the Bluff Road site do not represent a significant risk to human health, they do contain contaminants that may leach into the ground water. Therefore, remedial alternatives for the soils will be screened based on their effectiveness at reducing the soil contaminants toxicity, mobility, and volume and Implementability.

General Response					
Action	Remedial Technology	Process Option	Effectiveness	Implementability	Screening Conclusions
(continued)					
	Physical/chemical treatment	Neutralization	Only Effective and reliable for stabilizing pH of ground water prior to treatment	Readily implemented	Dismissed
		Precipitation/flocculation	Not Effective on organics	Readily implemented	Dismissed
		Ion exchange	Only Effective for removing low levels of metals from water	Readily implemented	Dismissed
		Air stripping	Effective for removal of volatile organics; not applicable to inorganics	Readily implemented	Retained
		Steam stripping	Effective for removal of volatile organics; other volatilization technologies exist.	Steam not available on site;	Dismissed
		Carbon adsorption	Very effective for organic contaminants; may have limited effectiveness on water soluble compounds	Readily implemented	Retained
	Biological treatment	Biological degradation	May not be effective due to chlorinated organics	Readily implemented using conventional equipment	Dismissed

49 0133

SECTION 5.0
DETAILED ANALYSIS OF REMEDIAL ALTERNATIVES

5.1 General

The purpose of the detailed analysis is to present an assessment of each remedial alternative's ability to meet certain evaluation criteria. This section of the feasibility study presents a detailed analysis of those ground water and soil remedial alternatives that were retained from the preliminary screening presented in Section 4.0. The remedial alternatives retained for further evaluation and analysis are:

Ground Water Remediation Alternatives

- o No Action Alternative
- o Carbon Adsorption
- o Air Stripping
- o Effluent Discharge Alternatives

Soil Remediation Alternatives

- o No Action Alternative
- o In-situ Soil Venting
- o Incineration
- o Thermal Desorption
- o Soil Excavation and Off-site Disposal
- o Soil Excavation and Off-site Thermal Treatment

The detailed analysis presented in this FS has been prepared in accordance with the NCP. The NCP has been revised to reflect the mandate of the SARA amendments and includes evaluation criteria to be used in conducting Feasibility Studies at Superfund Sites. As stated in the NCP, the detailed analysis in the Feasibility Study shall consist of an assessment of the remedial alternatives against each of seven evaluation criteria. Two additional criteria (State and Public acceptance) will be determined by the EPA at a later date and published in the Record of Decision. The evaluation criteria contained in the NCP and used in the detailed analysis presented in this Section are as follows:

- o Short-term Effectiveness
- o Long-term Effectiveness
- o Reduction of toxicity, mobility, or volume through treatment
- o Implementability
- o Compliance with ARARs
- o Overall Protection of human health and the environment
- o Cost

The detailed analysis of the remedial alternatives will also include a detailed technical description of the physical characteristics of the remedial alternative. Presented below is a description of the evaluation criteria used in the detailed analysis of remedial alternatives.

5.2 Description of Evaluation Criteria

5.2.1 Technical Description

The physical characteristics of the remedial alternatives are presented in the technical description. The technical description presented the technologies to be utilized to implement the alternative. In addition, unique engineering aspects (if any) of the physical components associated with the remedial alternative are presented.

5.2.2 Short-term Effectiveness

The short-term effectiveness of the remedial alternative is evaluated relative to its effect on human health and the environment during the implementation of the alternative. The evaluation of the alternative with respect to short-term effectiveness must consider the following:

- Short-term risks that might be posed to the community during implementation of the alternative;
- Potential impacts on workers during the remedial action and the effectiveness of protective measures; and

- Potential environmental impacts of the remedial action and the effectiveness of mitigative measures to be used during implementation.

5.2.3 Long-term Effectiveness

The evaluation of the remedial alternative relative to its long-term effectiveness is made by considering the risks that may remain after the remedial action objectives have been met. The following factors will be assessed in the evaluation of the alternatives long-term effectiveness;

- Environment impacts remaining from untreated waste or treatment residuals at the completion of the remedial alternative; and
- The adequacy and reliability of controls (if any) that will be used to manage treatment residuals or remaining untreated waste.

5.2.4 Reduction of Toxicity, Mobility, or Volume

This evaluation criteria addresses the degree to which remedial actions employ treatment technologies that will permanently and significantly reduce toxicity, mobility, or volume of the site contaminants and or the contaminated media.

The evaluation will focus on the following factors:

- The treatment process and the amount of hazardous materials to be treated;
- The degree of expected reduction in toxicity, mobility or volume and the degree to which the treatment will be irreversible; and
- The nature and quantity of treatment residuals that will remain after treatment.

5.2.5 Implementability

This evaluation addresses the technical and administrative feasibility of implementing the remedial alternative including

the availability of various services and materials required for implementation of the alternative. The following factors are considered during the implementability evaluation.

Technical Feasibility: This factor refers to the relative ease of implementing or completing the remedial alternative based on site-specific constraints. In addition, the constructability, operational reliability, and the ability to monitor the effectiveness of the remedial action are considered.

Administrative Feasibility: This factor refers to the ability and time required to obtain any necessary approvals and permits (if any).

5.2.6 Compliance with ARARs

In this section, the remedial alternative is evaluated for its compliance with applicable or relevant and appropriate requirements (ARARs). The following items are considered during the evaluation of the remedial alternative:

- o Compliance with chemical specific ARARs (e.g. MCLs);
- o Compliance with location specific ARARs (e.g. regulations pertaining to activities near floodplains, etc.); and
- o Compliance with action specific ARARs (e.g. RCRA minimum technology standards).

This evaluation also considers whether or not a remedial alternative would be in compliance with appropriate criteria, advisories, and guidances.

5.2.7 Overall Protection of Human Health and the Environment

This evaluation of the remedial alternative assesses whether the alternative provides adequate protection of human health

and the environment. The overall evaluation relies on the assessments conducted under other evaluation criteria including long-term and short-term effectiveness, and compliance with ARARs.

5.2.8 Cost

This criteria refers to the total cost to implement the remedial alternative. Total cost of each alternative represents the sum of the direct capital cost (materials, equipment and labor), indirect capital cost (engineering, licenses or permits, and the contingency allowances), and operation and maintenance cost. These costs are estimated with expected accuracies of -30 to +50 percent in accordance with EPA's "Guidance of Feasibility Studies Under CERCLA" document. These costs are developed for the purpose of comparison of the remedial alternatives. Capital costs include site work, system components installation, connection of utilities, buildings, etc. Administration and engineering costs are estimated in a range between 15 and 20 percent of the construction cost. Administration and Engineering costs for the alternatives with limited engineering work, such as off-site options, are estimated at 5 percent of the program cost. A 20-25 percent contingency factor is included to cover unforeseen costs incurred during construction. The major cost associated with operation and maintenance (O&M) include operating labor, energy, chemicals, and sampling and analysis.

Present worth costs were calculated for alternatives expected to last more than two years. In accordance with EPA guidance documents, a 5 percent discount rate (before taxes and after inflation) was used to determine the present worth factor.

5.3 Detailed Analysis of Ground-water Remediation Alternatives

5.3.1 No Action Alternative

The no-action alternative serves as a baseline for comparison of the overall effectiveness of each ground water remediation alternative.

5.3.1.1 Technical Description

The no action alternative would not utilize any active remedial technology for the ground water contaminant plume. The current interaction between the ground water plume and the surrounding environment would be allowed to continue. Under the no action alternative, institutional controls (access and deed restrictions) would be implemented at the site. The site currently has a fence around the accessible perimeter. Under the no action alternative, the existing fencing would be maintained and warning signs would be placed along the outside of the fence. Deed restrictions for properties surrounding the site would limit the use of upper aquifer ground water as a drinking water source.

In addition, ground water sampling and analysis would be conducted for the upper aquifer and lower aquifer to monitor any migration (horizontal and vertical) of the ground water plume.

5.3.1.2 Short-Term Effectiveness

Due to the fact that remedial action would not be implemented for the ground water plume, short-term risks to the community would not be present. The only potential impacts on workers would occur during ground water sampling events. Personnel involved with ground water sampling at the site would be required to comply with a site specific Health and Safety Plan to mitigate the potential impacts from worker exposure to ground water.

5.3.1.3 Long-Term Effectiveness

The baseline risk assessment presented in the Remedial Investigation Report concluded that the current site use poses no unacceptable levels of risk to public health or environment associated with the off-site migration of the ground water plume. For the future use scenarios, there appears to be concentrations of certain compounds in the ground water plume that may result in elevated levels of exposure, if all the health protective assumptions of the scenarios are realized.

Ground-water quality monitoring is demonstrated and reliable for detecting the migration of the ground water plume. Potential migration pathways would be monitored by ground water sampling and analysis over time.

5.3.1.4 Reduction of Toxicity, Mobility, or Volume

Under the no action alternative, treatment of the ground water plume would not occur. Therefore, the toxicity, mobility, and volume of the ground water plume contaminants would not be reduced. However, natural degradation will eventually reduce the toxicity, mobility, and the volume of the ground water plume contaminants. The rate for degradation would be slow and the time required to reach an acceptable level of contaminants in the ground water is unknown.

5.3.1.5 Implementability

The no action alternative is technically feasible and would employ common techniques for continued monitoring of the ground water plume. This alternative would not require any specific permits to implement.

5.3.1.6 Compliance with ARARs

Chemical Specific ARARs

Implementation of the no action alternative would not achieve compliance with the chemical specific ARARs (identified in Section 3.0) for ground water since the chemical compounds to remain in the ground water plume would exceed the Target Cleanup Levels.

Location Specific ARARs

Because the no action alternative would potentially allow the ground water plume contaminants to migrate into the lower aquifer and/or discharge into Myers Creek, the following location specific ARARs would apply:

- o Clean Water Act, Section 404
- o Fish and Wildlife Coordination Act

It is not possible at this time to determine if the migration of the ground water plume contaminants into Myers Creek would comply with the above listed location specific ARARs.

Action Specific ARARs

The applicable requirements associated with the no action alternative would be the regulations governing work at the site for the ground water monitoring actions and fence maintenance. These regulations are as follows:

- o OSHA - General Industry Standards (29 CFR 1910) which require respiratory protection and training for workers at the site;
- o OSHA - Safety and Health Standards (29 CFR 1926) which dictate safety procedures for work activities; and
- o OSHA - Record keeping, Reporting and Related Regulations (29 CFR 1904).

The ground water monitoring program and maintenance activities to be performed at the site would be designed to comply with the above listed action specific ARARs.

5.3.1.7 Overall Protection of Human Health and the Environment

The potential short-term impacts associated with the no action alternative would be mitigated by requiring personnel involved with any site activities (ground water sampling, maintenance) to comply with a site-specific Health and Safety Plan. The baseline risk assessment concluded that there appears to be concentrations of certain compounds in the ground water that may result in elevated levels of exposure if all the health protective assumptions of the future use scenario are realized (i.e. future drinking water scenario).

The no action alternative would not comply with the chemical specific ARARs for ground water. Activities under the no action alternative (ground water sampling, etc.) would comply with the identified action specific ARARs. It is not possible at this time to determine if any location specific ARARs would apply to the no action alternative because the ground water plume has not migrated to Myers Creek.

5.3.1.8 Cost

The costs associated with the no action alternative were assumed to include quarterly sampling of 16 monitoring wells (MW-1A, 1B, 3A, 3B, 7A, 7B, 7C, 8B, 9B, 9C, 10B, 11A, 11B, 12B, 12C, and 13B) for metals, volatile and semi-volatile organics for a period of thirty years. Reduction in the sampling frequency would be evaluated based on the results of the first year's quarterly monitoring. In addition, there would be the cost of fence and roadway

maintenance at the site. The total 30 year present worth cost of the no action alternative is \$760,000. A breakdown of the estimated no action alternative cost is presented in Table 5-1.

5.3.2 Ground Water Extraction and Treatment by Carbon Adsorption

5.3.2.1 Technical Description

This alternative consists of a combination of ground water extraction and ground water treatment. Contaminated ground water would be extracted from the upper aquifer by installing recovery wells. Ground water treatment would be accomplished by means of carbon adsorption. A pretreatment process, such as precipitation or flocculation, may be necessary to remove metals from the ground water prior to treatment by carbon adsorption. The need for any such pretreatment process would be evaluated as part of the remedial design activities.

The ground water extraction system would consist of a combination of recovery wells located within the contaminant plume, and at the periphery of the plume. Recovery wells would be placed in the more highly contaminated zone of the plume to facilitate rapid removal of organics. The periphery wells would be used to limit expansion of the plume. Figure 5-1 shows potential location of the ground water extraction wells.

The actual design of the extraction system including number, location, and configuration of wells would be performed during the remedial design. Pump tests and ground water modeling would be required for the design of the extraction system. For the purpose of this analysis, four extraction wells and a total flow of 100 gpm were used. The pumping rate is a conservative value based on data from the RI.

Carbon adsorption is a process by which the organic molecules in a waste stream are selectively attracted to the internal pores of the activated carbon granules. Adsorption is a surface attraction phenomenon which depends on the strength of the molecular attraction between adsorbent and adsorbate, molecular weight, type and characteristic of adsorbent, electrokinetic charge, pH, and surface area. The waste stream is usually contacted with the activated carbon by means of flow through a series of packed bed reactors.

Once the micropore surfaces of the carbon are saturated with organics, the carbon is "spent" and must either be replaced with virgin carbon or removed, thermally regenerated, and replaced. The time to reach "breakthrough" or exhaustion is the single most critical operating parameter. Carbon longevity balanced against influent concentration governs operating economics.

The ground water from the extraction wells would be pumped into a surge tank before it is fed to the carbon adsorption system. The carbon adsorption system would consist of units which contain granular activated carbon (GAC) and operate in a downflow mode. The downflow fixed bed mode has been found to be generally most cost-effective and produces the lowest effluent concentrations relative to other carbon adsorber configurations. The units will be connected in parallel to provide increased hydraulic capacity.

In order to minimize the carbon regeneration requirements, the carbon will be preceded by a pretreatment system (e.g. precipitation, filtration, etc.) to reduce suspended solids and inorganics such as iron.

The carbon adsorption system evaluated for the Bluff Road Site would include two-dual bed carbon units with each bed containing 20,000 lbs of GAC each. Preliminary evaluation of the assumed worst case influent (Table 5-2) indicates that 22,000 lbs of GAC would be used per day based on a ground water collection system providing 100 gpm. Four units would be needed to provide backup of other units during GAC regeneration. The acceptable effluent concentrations would require verification during remedial design. Once final influent and effluent concentrations are developed, field pilot plant testing would be recommended to accurately predict performance, longevity and operating costs.

5.3.2.2 Short-Term Effectiveness

Carbon adsorption is a proven technology that if properly designed and operated, will remove the semi-volatile and volatile contaminants and not pose a human health hazard during operation. The system would be a closed system with no air emissions, therefore, there would be no risk from the inhalation pathway.

The potential short-term risks to site workers, public health and the environment are:

- o Exposure to drilling fluids and soil during the installation of the ground water extraction wells.
- o Release of contaminated water because of accidental spillage.

To mitigate risk posed by exposure to site constituents during well installations, workers would be required to comply with a site specific health and safety plan (including requirements for protective clothing). The potential environmental risk due to accidental spillage of ground water would be mitigated by proper process design. The treatment system design would incorporate process controls such as level switches and extraction pump shut-off controls.

5.3.2.3 Long-Term Effectiveness and Permanence

Magnitude of Residual Risk: The ground water treatment system would be designed such that all contaminants contained in extracted ground water would be reduced to levels at or below MCLs, or ground water quality criteria prior to discharge. The ground water quality at the site would be improved to meet the remedial action objective (achievement of target cleanup levels).

To determine the magnitude of residual risk at the site after the ground water remedial action is complete, the future use drinking water scenario was reevaluated based on the target cleanup levels. The results of the post remediation risk assessment for ground water ingestion is presented in Appendix B.

The residuals resulting from operation of the treatment system would include filtered solids or settled solids and spent carbon. The carbon would be either regenerated or would be disposed by incineration or landfilling at a RCRA treatment, storage, and disposal facility. The filtered or settled solids would be disposed in accordance with applicable regulations depending upon the hazardous characteristics exhibited by the solids.

Adequacy and Reliability of Controls: The off-site RCRA incineration and/or landfill facility should operate within its permit(s) requirements and comply with all applicable regulations to effectively manage the treatment residuals (spent carbon or spent carbon regeneration waste). Monitoring programs required at RCRA landfills are designed to detect potential failures so that the necessary actions would be implemented to control the treatment residuals.

5.3.2.4 Reduction in Toxicity, Mobility, or Volume

The pumping system would control the mobility of contaminants by extracting ground water within the upper aquifer. The contaminated water would be treated by the carbon adsorption unit, thereby reducing the toxicity of the ground water. By repeated pumping and treatment of the contaminated volume, the mobility, toxicity, and volume of the contaminants would be reduced.

The organic compounds adsorbed to carbon would be removed and incinerated (carbon regeneration) to reduce their toxicity or would be placed in a RCRA landfill to reduce their mobility.

5.3.2.5 Implementability

Technical Feasibility: Carbon adsorption has been used extensively to treat contaminated ground water and has shown success in removing organic contaminants from ground water. Design and construction of the necessary treatment units would not pose a problem. Some equipment manufacturers offer modular units that can be made to fit an individual application with minor modification. Precipitation and filtration have been well demonstrated for removal of dissolved metals from aqueous streams. The equipment used in

these processes is proven and reliable, thus downtime for repairs and maintenance should be minimal.

During operation of the treatment system, the effectiveness of the treatment process would be monitored by periodically analyzing contaminant concentrations in the treated water prior to discharge. Monitoring of ground water would be necessary during the operation of the system to ensure that the periphery of the plume is being treated.

Administrative Feasibility: The use of carbon adsorption would require compliance with EPA, U.S. Department of Transportation, and SCDHEC regulations regarding the transport and disposal of hazardous materials (spent carbon, filtered and settled solids from pretreatment system). In addition, disposal regulations and criteria must be met for discharge of the treated water.

Availability of Services and Materials: A range of vendors are available to supply all necessary units of the treatment systems. Because of the large number of equipment suppliers, availability and scheduling considerations would not be anticipated to pose problems.

5.3.2.6 Compliance with ARARs

Chemical-Specific: This alternative is designed to treat the ground water contaminants to attain the target cleanup levels. Chemical-specific ARARs for the Bluff RoadSite were identified and discussed in Section 3.0. Several Federal and State regulations govern the quality, usage and discharge of ground water. Since ground water at the site has a GB classification under the South Carolina ground water protection strategy, federal criteria promulgated under the Safe Drinking Water Act (MCLs) would be relevant and appropriate cleanup levels. South Carolina Water Quality

would be approximately \$16,105,000.00. This cost would include a capital cost of \$1,390,000.00, and present worth O&M cost of \$14,715,000. A complete cost summary is included in Table 5-3.

Capital Cost: Capital expenditures would include construction of the ground water extraction system, a treated water discharge system, the treatment units, and all associated piping.

Operating Cost: The annual operating cost would be approximately \$1,357,125 each year. For a remedial action of 16 (based on 3 pore volumes of 263,296,000 each and 100 gpm pumping rate) years at a discount rate of 5%, the total O&M cost is \$14,715,000. The majority of the cost for operational and maintenance requirements for the treatment system is for carbon regeneration. Costs also include quarterly ground water monitoring of the well network and monthly monitoring of treatment plant effluent.

5.3.3 Ground Water Extraction and Treatment by Air Stripping

5.3.3.1 Technical Description

This alternative consists of a combination of ground water extraction and ground water treatment. Contaminated ground water would be extracted from the upper aquifer by installing recovery wells. Ground water treatment would be accomplished by means of air stripping towers, followed by a granular activated carbon (GAC) system. The more volatile constituents in ground water would be removed by air stripping, while semi-volatiles would be removed by the GAC system. A pretreatment process, such as precipitation or flocculation, may be necessary to remove metals from the ground water prior to treatment by air stripping and GAC. The need for any such

Standards would be applicable as the cleanup criteria.

Location-Specific: The ground water extraction and treatment system would be located on the Bluff RoadSite which is proximate to a wetland. Construction of this system as conceived would not impact the wetland but the radius of influence from the extraction wells may reach the wetland. This would require evaluation during the remedial design.

Action-Specific: This alternative would be designed to comply with action-specific ARARs. The action-specific ARARs for construction of the extraction and treatment systems, the treatment and subsequent disposal of the treated ground water and the management of treatment residuals were summarized in Section 3.0. Many RCRA Subtitle C requirements may apply because the site contains hazardous waste. RCRA Part 264 requirements may apply including standards for owners and operators of permitted hazardous waste facilities, preparedness and prevention, contingencies and emergency procedures, recordkeeping and reporting, and ground water monitoring. Federal OSHA worker health and safety requirements would be applicable to the construction and operation activities.

5.3.2.7 Overall Protection of Human Health and the Environment

This alternative would decrease the potential future risk resulting from direct contact and ingestion of site ground water because the ground water would be treated to meet the health protective target cleanup levels. This alternative can be implemented to meet identified ARARs.

5.3.2.8 Cost

The present worth cost of the Carbon Adsorption alternative,

pretreatment process would be evaluated as part of the remedial design activities.

The ground water extraction system would consist of a combination of recovery wells located within the contaminant plume, and at the periphery of the plume. Recovery wells would be placed in the more highly contaminated zone of the plume to facilitate rapid removal of organics. The periphery wells would be used to limit expansion of the plume. Figure 5-1 shows potential location of the ground water extraction wells.

The actual design of the extraction system including number, location, and configuration of wells would be performed during the remedial design. Pump tests and ground water modeling would be required for the design of the extraction system. For the purpose of this analysis, four extraction wells and a total flow of 100 gpm were used. The pumping rate is a conservative value based on data from the RI.

The ground water from the extraction wells would be pumped into a surge tank before it is fed to the air stripping system. The air stripping system would consist of two towers arranged in series. Both towers would have 12 feet of packing material, 30 inches in diameter and use high air-to-water ratios. The use of two air strippers in series offers the following benefits over a single air stripper with comparable treatment capacity:

- If one of the air strippers would require maintenance, the other air stripper could continue to operate;
- At some point one stripper may be sufficient to achieve treatment requirements allowing one stripper to be eliminated;

- Treatment capacity could be increased by running the strippers in parallel, should expansion of the extraction system become necessary.

Prior to treatment, the extracted ground water would contain the compounds identified in Table 5-2 at the estimated maximum concentration shown in Column 1. This ground water composition is a conservative estimate of contaminant concentrations during the first year of ground water extraction. Contaminant concentrations should steadily decrease from these levels. Actual treatment system influent composition would be defined during remedial design.

Air stripping can effectively remove most of these contaminants found in ground water at the Bluff Road Site (Golder, 1986). The exceptions would be 2-chlorophenol and phenols which would be removed by adsorption on the GAC.

After air stripping, the ground water would be pumped through cartridge filters and two carbon beds, also arranged in series. When the carbon in the first bed is spent, it would be replaced. A valve on the adsorption system would then be switched to reverse the order of the beds in the series. The beds are sized so that carbon would be expected to be replaced every 4 to 6 weeks. The system would be automated and designed for unattended operation. The final design of the ground water extraction system, air stripper, and GAC systems would require additional data collection prior to design.

As a result of ground water extraction and treatment, a discharge stream of treated ground water would be generated. As a best engineering judgement based on available data, the volumetric flow of the discharge stream is assumed to be 144,000 gallons per day based on a 100 gpm ground water recovery system operating 24 hours per day. More precise

ground water withdrawal and discharge values would be determined as part of the remedial design. Further discussion of effluent discharge alternatives is presented in Section 5.3.4.

5.3.3.2 Short-Term Effectiveness

Potential short-term risks to public health and the environment during the implementation of this alternative include the potential inhalation of organic vapors released from the air stripping process. An air dispersion model was used to calculate the ambient air quality resulting from the organic vapor emissions from the air stripper after vapor phase carbon adsorption treatment. The air dispersion modeling was conducted in accordance with applicable EPA guidance documents. Based on the results of the air dispersion model, a health evaluation was conducted to determine the potential risk, if any, to public health from the inhalation of organic vapors. The air dispersion model results and associated risk health evaluation are presented in Appendix C.

The air dispersion modeling for this alternative identified the downwind location where the maximum one-hour concentrations would be expected and the location where the maximum annual concentrations would be expected. The ambient air concentrations for the chemicals of concern at these locations determined by the air dispersion model were used to determine the potential risk, if any, to public health from the inhalation of organic vapors generated by the air stripping process.

The public health evaluation identified the following potential receptor groups which may experience maximum exposures to airborne contaminants:

1. Remediation workers in the immediate vicinity of the air stripper who might be exposed to short-term (one hour) peak concentrations;
2. Remediation workers present at the site for the duration of the remedial action (16 years) who might be exposed to airborne contaminants; and
3. Off-site residents who might be exposed to airborne contaminants for the duration of the remedial action (16 years).

For the first receptor group (remediation workers exposed for one hour to peak concentrations) the maximum predicted one-hour concentrations for each chemical of concern were compared to the Threshold Limit Values for those chemicals. Threshold Limit Values have been developed by the American Conference of Governmental and Industrial Hygienists (ACGIH) and are occupational exposure criteria that represent airborne concentrations of substances to which nearly all workers may be repeatedly exposed without adverse effects. The maximum predicted one-hour concentrations are far below the threshold limit values for occupational exposure, therefore, it is concluded that there is no danger of acute toxicity due to exposure to short-term emissions from the air stripper system.

For the second receptor group (remediation workers present at the site for the duration of the remedial action), the total cancer risk associated with exposure to maximum concentrations of all the chemicals of concern is estimated at 5.9×10^{-9} under the conditions of this scenario presented in Appendix C. The total hazard index for non-carcinogenic effects is 3.5×10^{-7} which is far below the 1.0 hazard index value which indicates a potential hazard.

To represent the third receptor group (off-site residents who might be exposed for the duration of the remedial action), a

child was used because of higher inhalation rate to body weight ratio, thus resulting in a worst case exposure scenario. For this receptor group, the total estimated cancer risk associated with exposure to maximum concentrations of all the chemicals of concern is 1.1×10^{-9} . The total hazard index for non-carcinogenic effects is 2.7×10^{-7} , which is far below the 1.0 hazard index value which indicates a potential hazard.

Two other potential short-term risks to site workers and the environment are:

- o Exposure to drilling fluids and soil during the installation of the ground water extraction wells.
- o Release of contaminated water because of accidental spillage.

To mitigate risk posed by exposure to site constituents during well installations, workers would be required to comply with a site specific health and safety plan (including requirements for protective clothing). The potential environmental risk due to accidental spillage of ground water would be mitigated by proper process design. The treatment system design would incorporate process controls such as level switches and extraction pump shut-off controls.

5.3.3.3 Long Term Effectiveness

Magnitude of Residual Risks

This ground water alternative would be implemented until the ground water concentrations would be reduced to the target cleanup levels. To determine the magnitude of residual risk at the site after the ground water remedial action is complete, the future use drinking water scenario was

reevaluated based on the target cleanup levels. The results of the post remediation risk assessment for ground water ingestion is represented in Appendix B.

The residuals resulting from operation of the treatment system would include filtered solids and spent carbon. The filtered solids and the carbon would be either regenerated at a permitted facility or would be disposed by incineration or landfilling at a RCRA treatment storage and disposal facility.

Adequacy and Reliability Controls

The off-site RCRA incineration and/or landfill facility should operate within its permit(s) requirements and comply with all applicable regulations to effectively manage the treatment residuals. Monitoring programs required at RCRA landfills are designed to detect potential failures so that the necessary actions would be implemented to control the treatment residuals.

5.3.3.4 Reduction in Toxicity, Mobility, and Volume

The pumping system would control the mobility of contaminants present by extracting ground water within the upper aquifer. Contaminated water would be treated by the air stripping and carbon adsorption units, thereby reducing the toxicity of the ground water. By continued pumping and treatment of the contamination plume, the mobility, toxicity, and volume of the contaminants in the ground water would be reduced. The organic compounds adsorbed to carbon would be removed and incinerated (carbon regeneration) to reduce their toxicity or would be placed in a RCRA landfill to reduce their mobility.

5.3.3.5 Implementability

Technical Feasibility: Both air stripping and carbon

adsorption have been used extensively at CERCLA sites and have showed success in removing organic constituents from ground water. Design and construction of the necessary treatment units would not pose a problem. Some equipment manufactures offer modular units that can be made to fit an individual application with minor modification.

During operation of the treatment system, the effectiveness of the treatment process would be monitored by periodically analyzing constituent concentrations of the treated water prior to discharge.

Administrative Feasibility: This alternative would require compliance with EPA, U.S. Department of Transportation, and SCDHEC regulations regarding the transport and disposal of hazardous materials (spent carbon and/or spent carbon regeneration waste).

Availability of Services and Materials: A wide range of vendors are available to supply all necessary units of the treatment system. Because of the large number of equipment suppliers, availability and scheduling considerations would not be anticipated to pose problems.

5.3.3.6 Compliance with ARARs

Chemical-Specific: This alternative is designed to treat the ground water contaminants to attain target cleanup levels. Chemical-specific ARARs were identified and discussed in Section 3.0. Several Federal and State regulations govern the quality, usage and discharge of ground water. Since the ground water at the site has a GB classification under the South Carolina ground water protection strategy, federal

criteria promulgated under the Safe Drinking Water Act (MCLs) would be relevant and appropriate cleanup levels. South Carolina Ground Water Quality Standards would also be appropriate.

Location-Specific: The ground water extraction and treatment system would be located on the Bluff RoadSite which is proximate to a wetland. Construction of this system as conceived would not impact the wetland but the radius of influence from the extraction wells may reach the wetland. This would require evaluation during remedial design.

Action-Specific: This alternative would be designed to comply with action-specific ARARs. The action-specific ARARs for construction of the extraction and treatment systems, the treatment and subsequent disposal of the treated ground water, and the management of treatment residuals are summarized in Section 3.0. Many RCRA Subtitle C requirements would apply because the Bluff RoadSite contains hazardous waste. RCRA Part 264 requirements that may apply include standards for owners and operators of permitted hazardous waste facilities, preparedness and prevention, contingency plan and emergency procedures, recordkeeping and reporting, and ground water monitoring. Federal OSHA worker health and safety requirements would be applicable to the construction and operation activities.

5.3.3.7 Overall Protection of Human Health and Environment

This alternative would decrease the potential future risks resulting from direct contact and ingestion of site ground water because the ground water would be treated to meet the health protective target cleanup levels. This alternative can be implemented to meet the identified ARARs.

5.3.3.8 Cost

The present worth cost for the Air Stripping alternative, would be approximately \$4,339,500. This cost would include a capital cost of \$1,013,000, and estimated annual O&M expenditures of \$306,875. A complete cost summary is included in Table 5.4.

Capital Cost: Capital expenditures would include construction of a ground water extraction system, the treatment units, a treated water discharge system, and all associated piping.

Operating Cost: The annual operating cost would be approximately \$306,875 each year. For a remedial action of 16 years at a discount rate of 5%, the total O&M cost is \$3,326,500. The majority of this cost is accounted for by the operational and maintenance requirements of the treatment system. Costs includes quarterly ground water monitoring of monitoring well network and monthly monitoring of treatment plant effluent. The cost estimate also includes the cost for management of the treatment residuals.

5.3.4 Effluent Discharge Alternatives

Effluent from either the air stripper or the GAC will require discharge of treated water to some location. The alternatives that have been evaluated as part of completion of the RI/FS include the following:

- Injection into the subsurface
- Discharge to the Columbia, SC Publically Owned Treatment Works (POTW)
- Discharge to Myers Creek
- Discharge to the Congaree River
- Spray irrigation into the wetland area

5.3.4.1 Subsurface Injection of Effluent

Infiltration galleries are a proven and viable alternative for effluent discharge. The process involves the use of drains, trenches and/or piping to introduce the treated ground water into the vadose zone where it is allowed to percolate into the soil. There are two basic types of infiltration galleries, horizontal and vertical. The horizontal system uses trenches lined with gravel or perforated piping to introduce the ground water into the vadose zone. Vertical infiltration uses vertical perforated piping with appropriate packing materials to allow radial infiltration over the depth of the vadose zone.

Discharge limitations for subsurface infiltration of the treated ground water will be the aquifer target cleanup levels. This effluent discharge option would establish the discharge design requirements for the ground water treatment system.

The effectiveness of this method is dependent on vadose zone acceptance of the treated water. A preliminary assessment of infiltration rates based on aquifer and near aquifer vadose zone soil classifications indicates that this technology would be feasible for the Bluff Road Site.

Percolation testing must be performed to determine permissible application rates of treated ground water and to establish the most appropriate process alternative (i.e., horizontal or vertical). The infiltration gallery must be located so that recharge to the aquifer does not interfere with the performance of the extraction system (hydraulic control). These considerations can be addressed adequately in design.

The basis for conceptual cost evaluation is a horizontal infiltration gallery. The estimated infiltration area required was determined using the lowest permeability determined by performing slug tests on shallow wells in the upper aquifer (9.27×10^{-4} cm/sec). This equates to an estimated permissible application rate of 50 gallons/day/ft². With an estimated flow rate of 100 gpm, approximately 3000 ft² of infiltration trenches would be required for horizontal infiltration. The infiltration trenches would be distributed over an area of approximately 15,000 square feet. This is based on a trench width of approximately 2 feet and trench spacing of approximately 7.5 feet (center to center). Again, permissible application rates would have to be confirmed during remedial design.

The present worth cost for the infiltration gallery effluent discharge alternative would be approximately \$165,484. This cost would include a capital cost of \$117,656, and estimated annual O&M expenditures of \$4412. A complete cost summary is included in Table 5-5.

5.3.4.2 Discharge to Columbia POTW

The effluent could be discharged to the Columbia POTW at an interceptor located approximately 6 miles from the Bluff Road Site. The Columbia POTW was contacted regarding discharge of treated effluent from the Bluff Road Site and informed representatives of the Group that discharge of treated ground water to a POTW is prohibited by local ordinance. This would eliminate the possibility of discharging effluent to the POTW as an option for consideration.

5.3.4.3 Discharge to Myers Creek

The maximum allowable chemical concentrations to a receiving

Class A stream such as Myers Creek or the Congaree River (see Section 5.3.4.4 below) would be based on Ambient Water Quality Criteria (where available) or RFDs. Table 5-2 provides these acceptable in-stream concentrations.

The following model would then be used to estimate the maximum acceptable concentration of chemicals in the discharge water from the ground water treatment system:

$$AC_i = (DC_i) (Q_d) / (Q_c + Q_d)$$

where

AC_i = the acceptable water concentration of the i^{th} chemical in the receiving stream (ug/l), $i = 1, \dots, 26$.

DC_i = the maximum acceptable water concentration of the i^{th} chemical in the discharge water (ug/l), $i = 1, \dots, 26$

Q_d = volumetric flow of the discharge stream (gal/day)

Q_c = 7Q10 volumetric flow of the receiving stream (gal/day)

By solving the above equation for DC_i , the following equation is derived:

$$DC_i = [(AC_i) (Q_c + Q_d)] / Q_d$$

The volumetric flow of the discharge stream is assumed to be 144,000 gallons per day. The estimated average daily volumetric flow in Myers Creek is 154,000 gallons per day (IT Corp., 1989).

The ground water treatment system design discharge concentrations will be contingent upon the selected effluent discharge alternative. The design basis will be established during remedial design. If Myers Creek is the selected alternative, the impacts of the discharge on creek levels (e.g. flood levels) should be evaluated during remedial design once accurate discharge quantities are obtained.

5.3.4.4 Discharge to Congaree River

The Congaree River has a greater flow and is classified the same as Myers Creek (Class A). Maximum allowable chemical concentrations in the treatment system discharge would be calculated as described in Section 5.3.4.3.

Discharge of effluent to the Congaree River would require an extensive overland piping system to transport the water approximately 2 to 3 miles to the river. This would also require access agreements and easements to be negotiated. The combination of these may limit the feasibility of this alternative.

As with Myers Creek, the impacts of the discharge on river levels (e.g. flood levels) should be evaluated as part of remedial design.

5.3.4.5 Spray Irrigation

Spray irrigation is a procedure by which effluent is discharged through a surface spray system. Spray irrigation is limited to those times when the ground is not frozen.

This alternative should be further evaluated during remedial design especially if it appears that the ground water recovery network will impact the water levels in the wetland area (see Appendix D). The spray irrigation design to recharge the wetland and offset the impacts of ground water withdrawal would be difficult due to poor percolation in off-site surface soils and potential flooding resulting from sheet flow to down gradient areas. Feasibility of this alternative is considered marginal.

5.4 Detailed Analysis of Soil Remediation Alternatives

5.4.1 No Action Alternative

The no action alternative serves as a baseline for comparison of the overall effectiveness of each soil remediation alternative.

5.4.1.1 Technical Description

The no action alternative would not utilize any active remedial technology for the site soils that are currently above the target cleanup levels. The current interaction between the site soils and the surrounding environment would be allowed to continue.

Under the no action alternative for soils, institutional controls (access and deed restrictions) would be implemented at the site to minimize potential human exposure to the soils. According to the Remedial Investigation Report, the principle environmental and human health threat posed by the site soils is the effect the soils would have on the ground water plume due to leaching of soil contaminants. The effect of the site soils on the ground water plume would be monitored by ground water quality sampling which would be conducted during the implementation of the selected ground water remedial alternative.

5.4.1.2 Short Term Effectiveness

Because remedial action for the soils would not be implemented, there would be no short-term environmental impacts or risks posed to the community.

5.4.1.3 Long Term Effectiveness

The baseline risk assessment presented in the Remedial Investigation Report concluded that the soils do not pose an

unacceptable risk to human health or the environment. However the soils may continue to leach contaminants into the ground water below the site. The baseline risk assessment concluded that there appear to be concentrations of certain compounds in the ground water that may result in elevated levels of exposure if all the health protective assumptions of the future use scenario are realized (i.e: future drinking water scenario).

5.4.1.4 Reduction of Toxicity, Mobility, or Volume

The toxicity, mobility, and volume of the contaminants present in the soils would not be reduced under the no action alternative because no treatment technologies would be employed. However, natural degradation would eventually reduce the toxicity, mobility, and volume of contaminants present in the site soils.

5.4.1.5 Implementability

The no action alternative is technically feasible. This alternative would not require any special permits to implement.

5.4.1.6 Compliance with ARARs

Chemical Specific ARARs

There are no ARARs for the site soils. However because the contaminated site soils are a source that could further degrade ground water quality, a soil/water partitioning model (Appendix A) was used to calculate target cleanup levels (TCLs) for the soils. The no action alternative would not meet the calculated TCLs for soils.

Location Specific ARARs

As stated in the detailed analysis for the no action ground water alternative, the following potential ARARs would apply if the ground water plume contaminants reached Myers Creek:

- o Clean Water Act, Section 404
- o Fish and Wildlife Coordination Act

Under the no action soil alternative, these ARARs may potentially apply if contaminants present in the soils leach into the ground water plume and subsequently migrate into Myers Creek.

Action Specific ARARs

There are no action specific ARARs for the no action soil remediation alternative.

5.4.1.7. Overall Protection of Human Health and the Environment

The no action alternative for soils may complement the potential future use risks associated with the ground water plume by contaminant leaching if the ground water plume is not remedied. There are no direct risks resulting from the no action soil remediation alternative. The no action alternative would not meet the calculated target cleanup levels for soils.

5.4.1.8 Cost

There are no capital or operational and maintenance costs associated with the no action alternative. The cost of monitoring the effect of site soils on the ground water plume are included in the cost for ground water quality monitoring under the ground water remedial alternatives.

5.4.2 In-Situ Soil Venting

5.4.2.1 Technology Description

Soil venting as proposed herein is an in-situ treatment process used to clean up soils that contain volatile and some semi-volatile organic compounds. The process utilizes extraction wells to induce a vacuum on subsurface soils. The subsurface vacuum propagates laterally, causing in-situ volatilization of compounds that are adsorbed to soils. Vaporized compounds and subsurface air migrate rapidly to extraction wells, essentially air stripping the soils in-place.

A vacuum extraction system consists of a network of air withdrawal (or vacuum) wells installed in the unsaturated zone. A pump and manifold system of PVC pipes is used for applying a vacuum on the air wells which feed an in-line water removal system, and an in-line vapor phase carbon adsorption system for VOC removal. Vacuum wells can either be installed vertically to the full depth of the contaminated unsaturated zone or installed horizontally within the contaminated unsaturated zone. If horizontal vacuum wells are utilized, the wells would require construction by trenching to mid-depth in the soil column. For the purposes of this evaluation, vertical wells were selected due to the depth of the soil strata requiring remediation and geotechnical conditions.

Once the well system has been installed and the vacuum becomes fully established in the soil column, VOCs would be drawn out of the soil and through the vacuum wells. In all soil venting operations, the daily VOC removal rates eventually decrease as volatiles are recovered from the soil. This occurs since volatile recovery decreases the VOC concentration in the soil, and consequently reduces the diffusion rate of volatiles from the soil. Volatiles in the air stream are removed by the

carbon adsorption system or destroyed by fume incineration, after which the cleaned air is discharged to the atmosphere.

The application of soil venting to the unsaturated zone remediation is a multi-step process. Specifically, full-scale vacuum extraction systems are designed with the aid of laboratory and pilot-scale VOC stripping tests. This would be performed as part of remedial design.

5.4.2.2 Short-Term Effectiveness

An air dispersion model was used to calculate the ambient air quality resulting from the organic vapor emissions from the soil venting system after vapor phase carbon adsorption treatment. The air dispersion modeling was conducted in accordance with applicable EPA guidance documents. Based on the results of the air dispersion model, a health evaluation was conducted to determine the potential risks, if any, to public health from inhalation of organic vapors. The air dispersion model results and associated health evaluations are presented in Appendix E.

The air dispersion modeling for this alternative identified the downwind location where the maximum one-hour concentrations would be expected and the location where the maximum annual concentrations would be expected. The ambient air concentrations for the chemicals of concern at these locations determined by the air dispersion model were used to determine the potential risk, if any, to public health from the inhalation of organic vapors generated by the in-situ soil venting process.

The public health evaluation identified the following

potential receptor groups which may experience maximum exposures to airborne contaminants:

1. Remediation workers in the immediate vicinity of the soil venting system who might be exposed to short-term (one-hour) peak concentrations;
2. Remediation workers present at the site for the duration of the remedial action (18 months) who might be exposed to airborne contaminants; and
3. Off-site residents who might be exposed to airborne contaminants for the duration of the remedial action (18 months).

For the first receptor group (remediation workers exposed for one hour to peak concentrations) the maximum predicted one-hour concentrations for each chemical of concern were compared to the Threshold Limit values for those chemicals. Threshold Limit Values have been developed by the American Conference of Governmental and Industrial Hygienists (ACGIH) and are occupational exposure criteria that represent airborne concentrations of substances to which nearly all workers may be repeatedly exposed without adverse effects. The maximum predicted one-hour concentrations are far below the Threshold Limit Values for occupational exposure, therefore, it is concluded that there is no danger of acute toxicity due to exposure to short-term emissions from the in-situ soil venting system.

For the second receptor group (remediation workers present at the site for the duration of the remedial action), the total cancer risk associated with exposure to maximum concentrations of all the chemicals of concern is estimated at 1.5×10^{-10} under the conditions of this scenario presented in Appendix E. The total hazard index for non-carcinogenic effects is 1.7×10^{-9} which is far below the 1.0 hazard index value which indicates a potential hazard.

To represent the third receptor group (off-site residents who might be exposed for the duration of the remedial action), a child was used because of higher inhalation rate to body weight ratio, thus resulting in a worst case exposure scenario. For this receptor group, the total estimated cancer risk associated with exposure to maximum concentrations of all the chemicals of concern is 2.1×10^{-10} . The total hazard index for non-carcinogenic effects is 2.3×10^{-9} which is far below the 1.0 hazard index value which indicates a potential hazard.

The potential short-term risks to site workers would be the exposure to drilling fluids and soil during the installation of the soil venting extraction wells. To mitigate these risks, workers would be required to comply with a site-specific health and safety plan (including provisions for protective equipment).

5.4.2.3 Long-Term Effectiveness

Magnitude of Residual Risk

The soil venting system would be designed and operated such that those contaminants in the soil which are considered to be a source of ground water contamination would be reduced to the target cleanup levels identified by the soil partitioning model. Therefore, the soils would no longer be a source contributing to the ground water plume and the remedial action objective for soil would be met.

Adequacy and Reliability of Controls

The residues resulting from the treatment system would include spent carbon used for vapor phase adsorption. This carbon would contain organic compounds and would be disposed in a

RCRA landfill or would be incinerated. The regeneration of spent carbon would also be a viable residuals management alternative. The adequacy and reliability of residuals management would be assured by using a permitted regeneration facility or a RCRA treatment, storage, and disposal facility.

5.4.2.4 Reduction of Toxicity, Mobility, and Volume

Soil venting would significantly reduce the volume of contaminants in the soil. Based on available literature and vendor information, target cleanup levels developed using the soil partitioning model are achievable using soil venting. The mobility of the organic compounds would be reduced because they would be removed from the soil and concentrated on the carbon. Permanent and significant reduction of the toxicity of organic contaminants would occur during the off-site thermal regeneration of carbon, (and subsequent destruction of organics) or by the incineration of the spent carbon. The mobility of the contaminants would be reduced by disposing the spent carbon in a RCRA landfill.

5.4.2.5 Implementability

Technical Feasibility

In-situ soil venting is a proven technology and has been applied in both pilot test and full scale remediation programs for stripping volatile organics and a number of semi-volatiles compounds from unsaturated soils and bedrock (see Table 5-6). The organic vapor treatment facilities (i.e. vapor phase carbon adsorption or fume incineration) have also been successfully implemented. Soil remediation at other CERCLA sites which had soils similar to the Bluff Road Site was accomplished by the use of in-situ soil venting. Golder, 1986 conducted laboratory testing on contaminated soils which showed that the affected site soils are amenable to air stripping. Pilot testing has not been conducted but would be recommended prior to design of the soil venting system.

During operation, the effectiveness of the system would be monitored by periodically analyzing contaminant concentration of the following:

- o Treated Soil
- o Untreated Vapor Entering the System
- o Treated Vapor

Administrative Feasibility: This alternative would require compliance with EPA, U.S. Department of Transportation, and SCDHEC regulations regarding transportation and disposal of hazardous materials (i.e. spent carbon). SCDHEC may require permits for the vapor discharge, however, since the unit will be equipped with all appropriate pollution control devices, permits may not be necessary.

5.4.2.6 Compliance with ARARs

Chemical Specific: Implementation of this alternative would achieve the target cleanup levels for soils as defined by the soil partitioning model (Section 3.0 and Appendix A).

Action-Specific: The alternative would be designed, constructed and operated to comply with action-specific ARARs. The action-specific ARARs for construction of the extraction and treatment system, the treatment and disposal of treated vapor, and disposal of residuals (spent carbon) are summarized on Table 3-5. Federal OSHA worker health and safety requirements would be applicable to the construction and operation activities and would be complied with by adhering to an approved work plan and health and safety plan. Many RCRA requirements may apply because the Bluff Road Site contains hazardous waste. RCRA Part 264 requirements that may apply include standards for owners and operators of permitted hazardous waste facilities, preparedness and prevention,

contingency plan and emergency procedures, recordkeeping and reporting.

It is anticipated that this alternative would comply with applicable portions of the Clean Air Act and the South Carolina Pollution Control Act.

5.4.2.7 Overall Protection of Human Health and the Environment

This alternative would decrease the potential future risks associated with the migration of organics contaminants into ground water from the soils. This alternative can be implemented to meet or exceed the identified ARARs. At the completion of the remediation, target cleanup levels for soil would be attained.

5.4.2.8 Cost

The estimated total cost for the soil venting system with vapor phase carbon adsorption would be approximately \$1,070,000. This capital cost includes the anticipated O&M expenditures since this remedial action is not expected to last over 2 years.

Capital cost would include construction of the soil vapor extraction system, vapor treatment system, and all associated piping/mechanical facilities (Table 5-7).

5.4.3 High Temperature Incineration

5.4.3.1 Technical Description

This alternative consists of excavation and treatment of the contaminated soils on-site using high temperature incineration. This treatment technology has been proven effective at treating soils that contain elevated levels of

organic contaminants. Prior to initiation of this remedial alternative, supplementary soil sampling would be performed to adequately delineate the volume of soil present above the target clean-up levels. Approximately 45,000 cubic yards of soil at the site is estimated to be above the TCLs.

Process Description

For the development of this alternative, the representative process option for high temperature incineration is the commercially available transportable rotary kiln incineration system.

This system uses a rotating refractory lined kiln to treat solids, soils, sludges and liquid wastes. The kiln is approximately 8 feet in diameter and 60 feet long. The soils would be heated to 1200°F to 1500°F by 60 mm BTU per hour oil fired fuel burners. The rotating kiln serves to mix, convey, and agitate the contaminated soil. After processing, the treated soil would be discharged from the kiln into a pug mill where it is moisturized by the addition of water to reduce dusting.

During incineration, combustion gas leaves the kiln at 1400°F to 1600°F and contains partially combusted organics, acid gases, entrained soil particles, and ash particulate. The combustion gas would pass through a hot cyclone for removal of relatively large particulate and would flow into a secondary combustion chamber (SCC). The SCC completes the combustion of the organic vapors from the soil by exposing the remaining organic vapors, carbon monoxide (CO) and carbonaceous particulate to temperatures in the range of 1800°F to 2200°F. The SCC is sized for a combustion gas residence time of at least two seconds at 2200°F.

For the organics present in the site soil, a temperature of 1800°F should be adequate to produce destruction and removal efficiencies (DREs) of at least 99.99%. The operational temperature necessary to achieve DREs of at least 99.99% would be determined during a pre-operational trial burn. The SCC will be fired by a 40 mm BTU per hour burner.

The combustion gas would leave the SCC at approximately 1800°F and enter the air pollution control (APC) system. The APC system would include an evaporative cooler, a baghouse, and a packed bed alkaline scrubbing unit.

The purge stream from the packed bed would be used for the evaporative cooler. Salts such as sodium chloride and sodium sulfate, which are formed in the packed bed, would be evaporated in the evaporative cooler and removed by a fabric filter. The combustion gas would leave the evaporative cooler at 300°F to 350°F, and enter the fabric filter where most of the remaining particulate would be removed. The combustion gas would then enter the packed bed for alkaline scrubbing removal of most of the acid gases. The combustion gas would exit the packed bed at approximately 185°F and enter the induced draft (ID) fan. The ID fan pulls the combustion gas through the entire incineration system and exhausts the combustion gas to the stack and out to the atmosphere. Stack emissions would be continuously monitored for carbon monoxide, oxygen, and the combustion gas velocity to verify compliance with Federal and State Regulations. An automatic waste feed cutoff system would be tied into various incinerator monitoring parameters such as temperature, carbon monoxide and waste feed rates in accordance with 40 CFR 264 Subpart O regulations and appropriate guidance documents.

The system requires an area of two to three acres. The equipment is assembled on over 30 trailers for transportation. The soil would be processed at a rate of approximately 20 tons per hour (for soil with a moisture content of about 20 percent). At an operating factor of about 80%, 190 days of continuous operation would be required to treat 72,900 ton (45,000 cubic yards) of soil. Mobilization, demobilization and decontamination of the incineration equipment will take about 60 days. Therefore implementation of on-site high temperature incineration is expected to take less than one year from the initial mobilization and start-up.

Site Preparation and Preprocessing

Prior to excavation, the site would be cleared of vegetation. Any existing foundations or concrete pads would be decontaminated and disposed accordingly.

Excavation and treatment would proceed in stages. The excavation rate should match the treatment rate in order to minimize the storage space required. Water spray would be used for dust control if necessary. Vapor suppression foams would be used if high levels of organic vapors in the breathing zone are detected during excavation. The excavated soil would be preprocessed in a tent structure of pole-barn construction and placed in piles. The storage space should be sized for adequate processing capacity to assure continuous operation during inclement weather.

The soil would be removed from the piles in the tent using a covered belt conveying system and would drop into a hopper over a scalping screen or shedder to remove oversized (greater than 2-inch) material and debris. The sorted material would

then be transported by an enclosed drag conveyor to a hopper that directly feeds the incinerator.

Rocks and other large objects would be screened and removed from the feed system, stockpiled on a pad, and decontaminated by steam cleaning. These materials would then be used as backfill on-site, after confirmatory sampling to assure adequate decontamination.

Residuals Treatment

Purge water from the scrubber would be recycled to the evaporative cooler where it would be evaporated. The salts and suspended solids contained in the purge water would be captured in the fabric filter.

Solids from the cyclone and fabric filter would be mixed with the treated soil after analytical testing verifies the absence of organic compounds and metals. If the solids are unacceptable for mixing with the soil, they would be stabilized and disposed off-site.

The treated soils would also be analyzed for organic compounds and EP Toxicity Metals. If the treated soils fail to meet these criteria, the soils would be stabilized prior to backfilling.

5.4.3.2 Short-Term Effectiveness

Potential risks to public health and the environment are associated with the excavation and treatment of the contaminated soils.

Air pollution control systems would be an integral part of the

on-site high temperature incinerator to limit air emissions to within the regulatory requirements. Stack and site perimeter monitoring will ensure that the discharge limits are not exceeded. An air dispersion model was used to calculate the ambient air quality resulting from the anticipated incineration air emissions (after treatment with air pollution control systems). The air dispersion modeling was conducted in accordance with applicable EPA guidance documents. Based on the results of the air dispersion model, a health evaluation was conducted to determine the potential risks, if any, to public health from the inhalation of emitted compounds. The air dispersion model results (including associated input data calculations) and the health evaluations are presented in Appendix F.

The air dispersion modeling for this alternative identified the downwind location where the maximum one-hour concentrations would be expected and the location where the maximum annual concentrations would be expected. The ambient air concentrations for the chemicals of concern at these locations determined by the air dispersion model were used to determine the potential risk, if any, to public health from the inhalation of emitted compounds generated by the high temperature incineration process.

The public health evaluation identified the following potential receptor groups which may experience maximum exposures to airborne contaminants;

1. Remediation workers in the immediate vicinity of the incinerator who might be exposed to short-term (one hour) peak concentrations;

2. Remediation workers present at the site for the duration of the remedial action (200 days) who might be exposed to airborne contaminants; and
3. Off-site residents who might be exposed to airborne contaminants for the duration of the remedial action (200 days).

For the first receptor group (remediation workers exposed for one hour to peak concentrations) the maximum predicted one-hour concentrations for each chemical of concern were compared to the Threshold Limit Values for those chemicals. Threshold Limit Values have been developed by the American Conference of Governmental and Industrial Hygienists (ACGIH) and are occupational exposure criteria that represent airborne concentrations of substances to which nearly all workers may be repeatedly exposed without adverse effects. The maximum predicted one-hour concentrations are far below the Threshold Limit Values for occupational exposure, therefore, it is concluded that there is no danger of acute toxicity due to exposure to short-term emissions from the high temperature incinerator.

For the second receptor group (remediation workers present at the site for the duration of the remedial action), the total cancer risk associated with exposure to maximum concentrations of all the chemicals of concern is estimated at 1.7×10^{-7} under the conditions of this scenario presented in Appendix F. The total hazard index for non-carcinogenic effects is 4.9×10^{-4} which is far below the 1.0 hazard index value which indicates a potential hazard.

To represent the third receptor group (off-site residents who might be exposed for the duration of the remedial action), a child was used because of higher inhalation rate to body weight ratio, thus resulting in a worst case exposure

scenario. For this receptor group, the total estimated cancer risk associated with exposure to maximum concentrations of all the chemicals of concern is 2.2×10^{-7} . The total hazard index for non-carcinogenic effects is 6.6×10^{-4} which is far below the 1.0 hazard index value which indicates a potential hazard.

Short term emissions of dust and organic vapors may occur during the excavation and pretreatment activities. These emissions may be mitigated by the proper use of water sprays, foams, and vapor control techniques. Downwind air monitoring for organics will be used to detect any off-site air emissions.

In addition, risks to workers may occur because of contaminant volatilization during waste excavation, and at the processing and stockpile areas. Workers involved with the waste excavation and processing activities may also be exposed to the additional risks associated with dermal contact with contaminated soils. Therefore, all workers would be required to wear appropriate protective equipment, as specified in the site specific health and safety plan.

5.4.3.3 Long-Term Effectiveness

Magnitude of Residual Risks The treated soil would be tested for leaching potential and organic compounds to ensure treatment below established clean-up levels is achieved. Treatability testing would be conducted to determine the expected organic and metal concentrations after treatment.

Adequacy of Controls Data available from vendors indicates a volatile organic removal rate of 99.99 percent or greater is achievable by high temperature incineration. Therefore, it is

expected that the target clean-up levels can be achieved by this technology.

Reliability of Controls The removal of volatile organics from the soil followed by incineration of the vapors is a permanent process.

5.4.3.4 Reduction in Mobility, Toxicity, or Volume

The thermal volatilization and thermal destruction of volatile organics from the soils provides the multiple benefit of reducing the toxicity, mobility, and volume of the organic compounds present in the soil. Destruction of at least 99.99% of the organics vaporized from the soil would be expected. The treatment process is irreversible and the treated soil is expected to meet the soil remediation goals. The volume of soil may be less than was processed in the system.

5.4.3.5 Implementability

Technical Feasibility The high temperature rotary kiln incineration process has been used in many projects to treat organic compounds present in soil. The soils present at these sites were treated to meet the respective remedial action objectives and the incineration processes were conducted to comply with the applicable ARARs.

Administrative Feasibility Acquisition of regulatory permits may not be required. However, the documentation for relevant and appropriate permit conditions would be provided to the State of South Carolina and to EPA to provide an opportunity for comment on the plans and specifications for the proposed remedial activities.

Currently, three vendors are known to have a total of five

mobile rotary kiln incineration systems in this size category. Treatment units are available that would have sufficient capacity to perform soils treatment at the site within a reasonable period of time. Advanced scheduling would be required to ensure that a mobile incineration system is available.

5.4.3.6 Compliance with ARARs

Chemical Specific ARARs

This alternative is expected to meet the calculated target clean-up levels (TCLs) for soils. The site soils above the TCLs would be excavated and treated by high temperature incineration to levels below the TCLs.

Action Specific ARARs

Action specific ARARs for this alternative apply to the excavation of contaminated soils, monitoring requirements, and operation of a thermal treatment unit.

Workers and worker activities that would occur during the implementation of this alternative must comply with the OSHA requirements for training, safety equipment and procedures, monitoring, recordkeeping, and reporting (see Table 3-5). In addition, the RCRA requirements for preparedness and prevention, contingency plans, and emergency procedures would also apply to this alternative. Compliance with the above mentioned ARARs would be achieved by following an EPA approved work plan and a site-specific health and safety plan.

The RCRA standards for permitted hazardous waste facilities, including performance standards (40 CFR 264), would apply to the high temperature incineration unit. To achieve compliance

with these ARARs, the unit used would be designed, constructed, and operated in accordance with the provisions contained in the RCRA hazardous waste facility regulations.

This alternative would result in air emissions. The applicable requirements for air emissions would be the Prevention and Significant Deterioration (PSD) air emission provisions contained in the Clean Air Act and the requirements contained in the South Carolina Pollution Control Act. It is anticipated that the treatment system will not exceed the PSD limits and would comply with South Carolina Pollution Control Act requirements for air emissions.

The action specific ARAR of the RCRA Land Disposal Restrictions would not apply for the backfilling of treated soils at the Bluff Road site because the remediation is a CERCLA remedial action.

5.4.3.7 Overall Protection of Human Health and the Environment

This alternative would destroy the organic contaminants present in the soils thus reducing the toxicity, mobility, and volume of the contaminants. Therefore, this alternative would meet the remedial action objectives for soil. Protection of human health and the environment would be achieved by meeting the remedial objectives and by complying with the identified ARARs.

5.4.3.8 Cost

The capital cost associated with this alternative include site preparation, incineration unit mobilization and demobilization, pilot testing, the construction of support facilities, soil excavation and treatment, site restoration,

and a mobile laboratory. Due to the short implementation period associated with this alternative the operation and maintenance cost for this alternative are incorporated in the capital cost. Therefore, a present worth analysis has not been performed for this alternative. The estimated cost of this alternative (based on 45,000 cubic yard of soil) is \$28,260,000. A detailed breakdown of the estimated costs associated with this alternative are presented in Table 5-8.

5.4.4 Low Temperature Thermal Desorption

5.4.4.1 Technical Description

This alternative consists of excavating the site soils and treating the soils on-site using low temperature thermal desorption. This treatment technology has been proven effective at treating soils that contain elevated levels of organic contaminants. Approximately 45,000 cubic yards of soil at the site is estimated to be above the target clean-up levels. Prior to initiation of this remedial alternative, supplementary soil sampling would be performed to adequately delineate the volume of soil present above these levels.

Process Description

For the development of this alternative, the representative process option for low temperature thermal desorption is the commercially available modified asphalt kiln. This system uses a rotating kiln with soil lifters inside the kiln to mechanically agitate the soil and improve heat transfer. The kiln is approximately 8 feet in diameter and 40 feet long. The soil would be heated to approximately 600°F by a 50mm BTU per hour fuel oil burner firing in the kiln.

The rotating kiln and lifters serve to mix, convey, and

agitate the contaminated soil, allowing the moisture and volatile organic compounds (VOC's) to vaporize and escape from the soil. After processing, the soil would be discharged from the kiln into a pug mill where it is moisturized by the addition of water to reduce dusting problems.

The combustion gas leaves the kiln at about 300 to 400°F and contains vaporized VOCs and extrained soil particles. The combustion gas would pass through a cyclone, a baghouse, a wet scrubber, and a bed of granular activated carbon. The cyclone and baghouse remove the soil particulate. The wet scrubber removes acid gases, and the carbon bed removes any remaining VOCs. Stack emissions would be monitored to verify compliance with federal and state regulations, including those for VOCs, hydrochloric acid (HCl), carbon monoxide (CO) and particulate loading.

The system requires an area of about 100 feet by 100 feet. The equipment is assembled on seven trailers for easy transportation. The soil would be processed at a rate of approximately 40 tons per hour (for soil with a moisture content of approximately 20 percent). At an operating factor of about 80%, approximately 95 days of continuous operation would be required to treat 72,900 tons (45,000 cubic yards) of soil. Mobilization, demobilization and decontamination of the low temperature desorption equipment will take about 30 days. Therefore, implementation of on-site low temperature thermal desorption is expected to take less than one year.

Site Preparation and Preprocessing

Prior to excavation, the site would be cleared of vegetation. Any existing foundations or concrete pads would be decontaminated and disposed accordingly.

Excavation and treatment will progress in stages. The excavation rate should match the treatment rate in order to minimize the storage space required. Water spray would be used for dust control if necessary. Vapor suppression foams would be used if high levels of organic vapors in the breathing zone are detected during excavation. The excavated soil would be preprocessed in a tent structure of pole-barn construction and placed in piles. The storage space should be sized for adequate processing capacity to assure continuous operation during inclement weather.

The soil would be removed from the piles in the tent using a covered belt conveying system and would drop into a hopper over a scalping screen or shredder to remove oversized (greater than 2-inch) material and debris. The sorted material would then be transported by an enclosed drag conveyor to a hopper that directly feeds the low temperature thermal desorption unit.

Rocks and other large objects would be screened and removed from the feed system, stockpiled on a pad, decontaminated by steam cleaning. These materials would then be used as backfill on-site, after confirmatory sampling to assure adequate decontamination.

Residuals Treatment

The water from the wet scrubber would be treated with a two-stage carbon adsorption system, and then used for ash quenching. Spent carbon from the system would be sent to an off-site hazardous waste incinerator for disposal. Soil particles from the cyclone and baghouse would be mixed with the treated soil from the thermal desorber after analytical testing verifies the absence of organic compounds and metals.

The excavated area would be backfilled with the treated soil. The treated soil would be analyzed for volatile organics prior to backfilling. If treated soil contains organic compounds above the target clean-up levels, then these soils would be recycled back into the treatment unit. The treated soils would also be analyzed for EP toxicity metals. If the treated soils fail to meet these criteria, the soils would be stabilized prior to backfilling. The treated soil would have sufficient properties to allow for standard grading and compaction equipment for backfilling operations. The area would be graded to match with existing drainage, covered with one foot of topsoil, and revegetated to minimize erosion.

5.4.4.2 Short-Term Effectiveness

Potential risks to public health and the environment are associated with the excavation and treatment of the contaminated soils.

Air pollution control systems will be an integral part of the low temperature thermal desorption system to limit air emissions to within the regulatory requirements. Stack and site perimeter monitoring will ensure that the discharge limits are not exceeded. An air dispersion model was used to calculate the ambient air quality resulting from the anticipated thermal desorption air emissions (after treatment with air pollution control systems). The air dispersion modeling was conducted in accordance with applicable EPA guidance documents. Based on the results of the air disperison model, a health evaluation was conducted to determine the potential risk, if any, to public health from the inhalation of emitted compounds. The air dispersion model results (including associated input data calculations) and the health evaluations are presented in Appendix G.

The air dispersion modeling for this alternative identified the downwind location where the maximum one-hour concentrations would be expected and the location where the maximum annual concentrations would be expected. The ambient air concentrations for the chemicals of concern at these locations determined by the air dispersion model were used to determine the potential risk, if any, to public health from the inhalation of emitted compounds generated by the thermal desorption process.

The public health evaluation identified the following potential receptor groups which may experience maximum exposures to airborne contaminants;

1. Remediation workers in the immediate vicinity of the thermal desorber who might be exposed to short-term (one hour) peak concentrations;
2. Remediation workers present at the site for the duration of the remedial action (100 days) who might be exposed to airborne contaminants; and
3. Off-site residents who might be exposed to airborne contaminants for the duration of the remedial action (100 days).

For the first receptor group (remediation workers exposed for one hour to peak concentrations) the maximum predicted one-hour concentrations for each chemical of concern were compared to the Threshold Limit Values for those chemicals. Threshold Limit Values have been developed by the American Conference of Governmental and Industrial Hygienists (ACGIH) and are occupational exposure criteria that represent airborne concentrations of substances to which nearly all workers may be repeatedly exposed to without adverse effects. The maximum predicted one-hour concentrations are far below the Threshold

Limit Values for occupational exposure, therefore, it is concluded that there is no danger of acute toxicity due to exposure to short-term emissions from the thermal desorption unit.

For the second receptor group (remediation workers present at the site for the duration of the remedial action), the total cancer risk associated with exposure to maximum concentrations of all the chemicals of concern is estimated at 4.3×10^{-7} under the conditions of this scenario presented in Appendix F. The total hazard index for non-carcinogenic effects is 9.1×10^{-4} which is far below the 1.0 hazard index value which indicates a potential hazard.

To represent the third receptor group (off-site residents who might be exposed for the duration of the remedial action), a child was used because of higher inhalation rate to body weight ratio, thus resulting in a worst case exposed scenario. For this receptor group, the total estimated cancer risk associated with exposure to maximum concentrations of all the chemicals of concern is 5.7×10^{-7} . The total hazard index for non-carcinogenic effects is 1.2×10^{-3} which is far below the 1.0 hazard index value which indicates a potential hazard.

Short term emissions of dust and organic vapors may occur during the excavation and pretreatment activities. These emissions may be mitigated by the proper use of water sprays, foams, and vapor control techniques. Downwind air monitoring for organics will be used to detect any off-site air emissions.

In addition, risks to workers may occur because of contaminant

volatilization during waste excavation, and at the processing and stockpile areas. Workers involved with the waste excavation and processing activities may also be exposed to the additional risks associated with dermal contact with contaminated soils. Therefore, all workers would be required to wear appropriate protective equipment, as specified in the site specific health and safety plan.

Short term emissions of dust, and organic vapors, may occur during the excavation and pretreatment activities. These emissions may be mitigated by the proper use of water sprays, foams, and vapor control techniques. Downwind air monitoring for organics will be used to detect any off-site air emissions.

Risks to workers may occur because of contaminant volatilization during waste excavation, and at the processing and stockpile areas. To mitigate the risks, an approved work plan and a site-specific health and safety plan would be prepared and followed. Workers involved with the waste excavation and processing activities may also be exposed to the additional risks associated with dermal contact with contaminated soils. Therefore, all workers would be required to wear appropriate protective equipment, as specified in the site-specific health and safety plan.

5.4.4.3 Long-Term Effectiveness

Magnitude of Residual Risks: The treated soil would be tested for leaching potential of organic compounds to ensure treatment below established clean-up levels is achieved. Since the extraction efficiency for volatile organics is expected to be high, treatment residuals are not expected to contain organic contaminants above the target clean-up level.

Treatability testing would be conducted during remedial design to determine the expected organic concentrations after treatment. Carbon used for vapor treatment would be disposed of off-site at a RCRA incineration and/or landfill facility or would be regenerated at an approved facility.

Adequacy and Reliability of Controls: Data available from a vendor indicates a volatile organic removal rate of 99.9 percent or greater is achievable by low temperature thermal desorption. Therefore, it is expected that the clean-up levels selected can be achieved by this technology. The removal of volatile organics from the soil by low temperature thermal desorption followed by the carbon bed adsorption of the collected vapors is a permanent process.

The spent carbon or carbon regeneration waste would be disposed at a permitted RCRA incineration and/or landfill facility to ensure adequate management of the treatment residuals.

5.4.4.4 Reduction in Mobility, Toxicity, or Volume

This alternative provides the multiple benefit of reducing the toxicity and mobility of organic contaminants present in the soil. The treatment process is irreversible and the treated soil is expected to meet the soil remediation goals. The volume of soil may be less than was processed in the system.

5.4.4.5 Implementability

Technical Feasibility: The low temperature thermal desorption process has been used in several projects to treat volatile organics in soil. The system is commercially available through several vendors as trailer mounted transportable

systems. The thermal desorption process has been used at a number of CERCLA sites.

Administrative Feasibility: Acquisition of regulatory permits may not be required, although the documentation for relevant and appropriate permits conditions would be provided to the State of South Carolina and to EPA to provide an opportunity for their to comment on the plans and specifications for the systems. The thermal desorption process has been used at a number of CERCLA sites.

Action Specific ARARs

The applicable requirements associated with the no action alternative would be the regulations governing work at the site for the ground water monitoring actions and fence maintenance. These regulations are as follow proposed remedial activities.

Currently, five vendors are known to own low temperature desorption process equipment. Therefore, treatment units are available that would have sufficient capacity to perform soils treatment at the site within a reasonable period of time. Advanced scheduling will be required to ensure that a low temperature thermal desorption unit is available.

5.4.4.6 Compliance With ARARs

Chemical Specific ARARs

This alternative is expected to meet the calculated target clean-up levels (TCLs) for soils. The site soils above the TCLs would be excavated and treated by low temperature thermal desorption to levels below the TCLs.

Action Specific ARARs

Action specific ARARs for this alternative apply to the excavation of contaminated soils, monitoring requirements, and operation of a thermal treatment unit.

Workers and worker activities that would occur during the implementation of this alternative must comply with the OSHA requirements for training, safety equipment and procedures, monitoring, recordkeeping, and reporting. In addition, the RCRA requirements for preparedness and prevention, and contingency plans, and emergency procedures would also apply to this alternative. Compliance with the above mentioned ARARs would be achieved by following an EPA approved work plan and a site-specific health and safety plan.

The RCRA standards for permitted hazardous waste facilities including performance standards (40 CFR 264) would apply to the low temperature thermal desorption unit. To achieve compliance with these ARARs, the unit used would be designed, constructed, and operated in accordance with the provisions contained in the RCRA waste facility regulations.

This alternative will result in air emissions. The applicable requirements for air emissions would be the Prevention and Significant Deterioration (PSD) air emission provisions contained in 40 CFR 51 and the requirements contained in the South Carolina Pollution Control Act. It is anticipated that the treatment system will not exceed the PSD limits and will comply with South Carolina Pollution Control Act requirements for air emissions.

The action specific ARAR of the RCRA Land Disposal Restrictions would not apply for the backfilling of treated

soils at the Bluff Road site because the remediation is a CERCLA remedial action.

The activated carbon, which would contain elevated levels of organic compounds, would be transported and incinerated off-site. The RCRA and U.S. Department of Transportation requirements for the packaging and transportation of hazardous waste would be applicable. Compliance with these ARARs would be achieved by utilizing a licensed hazardous waste transporter. The ARARs for off-site incinerators would be complied with by disposing of the carbon at an EPA permitted RCRA incineration facility.

5.4.4.7 Overall Protection of Human Health and the Environment

This alternative would remove the organic contaminants from the soil to meet the remedial objectives for soil. The toxicity, mobility, and volume of the contaminants present in the soil would be reduced. Protection of human health and the environment would be achieved by complying the the identified ARARs.

5.4.4.8 Costs

The capital costs associated with this alternative include site preparation, thermal treatment unit mobilization and demobilization, pilot testing, construction of support facilities, soil excavation and treatment, backfilling, revegetation, mobile laboratory, and environmental monitoring. Due to the short implementation period associated with this alternative the operational and maintenance costs for this alternative are incorporated in the capital costs. Therefore, a present worth analysis has not been performed for this alternative. The estimated cost of this alternative (based on 45,000 cubic yard of soil) is \$18,250,000. A

detailed breakdown of the estimated costs associated with this alternative are presented in Table 5-9.

5.4.5 SOIL EXCAVATION AND OFF-SITE DISPOSAL

5.4.5.1 Technical Description

This alternative consists of excavating the site soils that are above the target clean-up level and transporting the excavated soils to an off-site RCRA landfill for disposal. Prior to initiation of the remedial design for this alternative, supplementary soil sampling would be performed to adequately delineate the volume of soil present above the target clean-up levels. Approximately 45,000 cubic yards of soil is estimated to be above the target clean-up levels at the site.

Prior to excavation, the site would be cleared of vegetation. Any existing foundations or concrete pads would be decontaminated and disposed accordingly.

An equipment staging area would be constructed for equipment storage. In addition, a mobile analytical laboratory would be installed on-site and used to provide quick turn around on soil samples to verify that the affected site soils have been adequately removed. Excavation at the site is expected to be routine and would be accomplished using conventional construction equipment. Excavated soil would be placed directly into lined 20 cubic yard capacity trucks. Trucks would be decontaminated prior to leaving the site. Disposal of the site soils would be accomplished at a RCRA landfill. Analytical testing of the soils for EP Toxicity Metals and Toxicity Characteristic Leaching Procedure (TCLP) will be required to determine if the soils can be disposed untreated in a RCRA land fill in accordance with the RCRA Land Disposal

Restrictions (40 CFR 268). The Land Disposal Restrictions go into effect for CERCLA soils in November, 1990. If the soil cannot be land disposed, then pretreatment of the soils (i.e. solidification/fixation) would be required.

The excavated areas would be backfilled with clean fill/backfill material. A one-foot layer of topsoil would also be installed. The site would be graded to promote drainage and would be revegetated.

5.4.5.2 Short-Term Effectiveness

Potential short-term risks to public health and the environment are associated with the excavation and handling of the contaminated soil. Potential risks to the public may result from inhalation of volatilized contaminants or fugitive dust during excavation and from accidents during transportation of excavated soil.

The potential risks posed to the community and the environment from volatilized organics or dust would be mitigated by the use of water sprays and foam suppressants during the remedial action. In addition, downwind air sampling would be performed to monitor any off-site emissions of volatile organics.

A site-specific health and safety plan (including protective equipment and monitoring equipment to be used) would be prepared and adhered to during the remedial action to minimize risks posed to workers.

To reduce the potential risks to public health or the environment resulting from an accident during transportation of the soils, a traffic control plan including routing of trucks to avoid populated areas would be developed and followed.

5.4.5.3 Long-Term Effectiveness

Magnitude of Residual Risks

Upon removal and disposal of the site soils that are above the target clean-up levels, the soil remediation objective will be achieved. Therefore, the leaching potential of the site soils into the ground water plume would be eliminated.

Adequacy of Controls

There would be no soils left at the site that have concentrations above the target clean-up levels, therefore monitoring of the backfill and remaining site soils is not necessary. The ground water plume would be monitored no matter which ground water remedial action is implemented.

Reliability of Controls

Disposal of the excavated soils at a RCRA landfill would effectively isolate the contaminants of concern presented in the soils. Monitoring programs required at RCRA landfills are designed to detect potential failures so that corrective actions can be undertaken to mitigate the threat of a release.

5.4.5.4 Reduction of Toxicity, Mobility, or Volume

If no treatment technology (i.e. stabilization to meet Land Ban requirements) is employed, there would be no reduction in toxicity and volume of the contaminants. However the mobility of the contaminants would be decreased by placing the soils in a RCRA landfill.

5.4.5.5 Implementability

Technical Feasibility

Excavation and transportation of contaminated soils are common construction activities, and are considered technically feasible. The removal and transport of the contaminated soils is limited by the removal/excavation rate and/or the rate at which the materials can be accepted at the RCRA landfill facility. A waste profile sheet and a statement certifying the material as nonreactive must be provided to the landfill facility before the waste can be accepted.

RCRA manifest requirements must be complied with for all wastes shipped off-site. Effective November 8, 1990, volatile organic contaminated soil and debris resulting from a response action taken under Section 104 or 106 of CERCLA are prohibited from land disposal without treatment if the soils contain contaminants above certain limits established in 40 CFR 268. Pretreatment of the soils may be necessary at the site or may be accomplished at the disposal facility. The Land Disposal Restriction regulations will significantly increase the cost of disposed soils by landfilling.

Administrative Feasibility

Implementation of this alternative may require coordination with municipalities to determine the appropriate transportation routes.

Numerous remedial action contractors and hazardous waste transporters are available for the excavation and transportation of the site soils. Coordination and advanced planning is require to ensure that capacity is available at a RCRA landfill.

5.4.5.6 Compliance with ARARs

Chemical Specific ARARs

This alternative is expected to meet the calculated target clean-up levels (TCLs) for soils. The site soils above the TCLs would be excavated and disposed in a RCRA landfill.

Action Specific ARARs

Action specific ARARs for this alternative apply to the excavation of contaminated soils, monitoring requirements, and transportation and disposal requirements.

Workers and worker activities that would occur during the implementation of this alternative must comply with the OSHA requirements for training, safety, equipment and procedures, monitoring, recordkeeping and reporting. Also, the RCRA requirements for preparedness and prevention, contingency plans, and emergency procedures would apply to this alternative. Compliance with the above mentioned ARARs would be achieved by following on EPA approved work plan and a site-specific health and safety plan.

The action specific ARARs for disposal of soils in a RCRA landfill resulting from a CERCLA remedial activity are the RCRA Land Disposal Restriction regulations in 40 CFR 268 (effective November, 1990). The site soils would be analyzed for EP toxicity metals and TCLP parameters. If the soils are above the concentration limits acceptable for disposal in a RCRA landfill, then pretreatment of the soils to meet the land disposal regulations would be required to comply with this ARAR.

The RCRA and U.S. Department of Transportation requirements

for the packaging and transportation of hazardous waste would be applicable to this alternative. Compliance with these ARARs would be achieved by utilizing a licensed hazardous waste transporter.

5.4.5.7 Overall Protection of Human Health and the Environment

The excavation of the site soils and subsequent disposal in a RCRA landfill would meet the soil remediation objectives. The mobility of the soil contaminants would be reduced by placement of the soils in a RCRA landfill. Protection of human health and the environment would be achieved by complying with the identified ARARs.

5.4.5.8 Cost

The capital costs associated with this alternative include site preparation, excavation, transportation and disposal costs, and site restoration. Because of the relatively short implementation period associated with this alternative, operational and maintenance cost are incorporated in the capital cost. Therefore, a present worth analysis has not been performed for this alternative. The estimated cost of this alternative (based on 45,000 cubic yards of soil) is \$20,700,000. A detailed breakdown of the estimated costs associated with this alternative are presented in Table 5-10.

5.4.6 Soil Excavation and Off-site Thermal Treatment

5.4.6.1 Technical Description

This alternative consists of excavating the site soils that are above the target clean-up levels and transporting the excavated soils to an off-site RCRA incinerator for treatment and disposal. Prior to initiation of the remedial design for this alternative, supplementary soil sampling would be performed to adequately delineate the volume of soil present

above the target clean-up levels. Approximately 45,000 cubic yards of soil is estimated to be above the target clean-up levels at the site.

Prior to excavation, the site would be cleared of vegetation. Any existing foundations or concrete pads would be decontaminated and disposed accordingly. An equipment staging area would be constructed for equipment storage. In addition, a mobile analytical laboratory would be installed on-site and used to provide quick turn around on soil samples to verify that the affected site soils have been adequately removed.

Excavated soil would be placed directly into lined 20 cubic yard capacity trucks. Trucks would be decontaminated prior to leaving the site. Thermal treatment of the soil would be completed at a RCRA-permitted incineration facility. Treated soil would then be disposed in a landfill (most incineration facilities have associated landfills for disposal of treated wastes).

The excavated areas would be backfilled with clean fill/backfill material. A one-foot layer of topsoil would also be installed. The site would be graded to promote drainage and would be revegetated.

5.4.6.2 Short-Term Effectiveness

Potential short-term risks to public health and the environment are associated with the excavation and handling of the contaminated soil. Potential risks to the public may result from inhalation of volatilized contaminants or fugitive dust during excavation and from accidents during transportation of excavated soil.

The potential risks posed to the community and the environment from volatilized organics or dust would be mitigated by the use of water sprays and foam suppressants during the remedial action. In addition, downwind air sampling would be performed to monitor any off-site emissions of volatile organics.

A site-specific health and safety plan (including protective equipment and monitoring equipment to be used) would be prepared and adhered to during the remedial action to minimize risks posed to workers.

To reduce the potential risks to public health or the environment resulting from an accident during transportation of the soils, a traffic control plan including routing of trucks to avoid populated areas would be developed and implemented

5.4.6.3 Long-Term Effectiveness

Magnitude of Residual Risks

The soil remediation objectives will be achieved upon the excavation and disposal of the site soils that are above the target clean-up levels. Therefore, the leaching potential of the site soils into the ground water plume will be eliminated.

No soils will be left at the site that have concentrations above the target clean-up levels, therefore monitoring of the backfill and remaining site soils is not necessary. The ground water plume will be monitored no matter which ground water remedial action is implemented.

Adequacy and Reliability of Controls

The off-site RCRA incineration and landfill facility should operate within its permit(s) requirements and comply with all applicable regulations. Monitoring programs required at RCRA landfills are designed to detect potential failures so that the necessary actions would be implemented to control the treatment residuals.

5.4.6.4 Reduction of Toxicity, Mobility, or Volume

Implementation of this alternative would reduce the toxicity, mobility, and volume of the contaminants present in the site soils. This reduction of toxicity, mobility, and volume is accomplished by the thermal destruction of organic contaminants.

5.4.6.5 Implementability

Technical Feasibility

Excavation and transportation of contaminated soils are common construction activities, and are considered technically feasible. The removal and transport of the contaminated soils is limited by the excavation rate and/or the rate at which the materials can be accepted at the RCRA incineration facility. RCRA hazardous waste requirements must be complied with for all wastes transported off-site.

The RCRA incinerator would be effective at destroying the organic compounds present in the soils. The landfill would reliably isolate the treated soils.

Administrative Feasibility

Implementation of this alternative may require coordination with municipalities to determine the appropriate transportation routes.

Numerous remedial action contractors and hazardous waste transporters are available for the excavation and transportation of the site soils. Coordination and advanced planning is required to ensure that capacity is available at a RCRA incineration facility.

5.4.6.6 Compliance with ARARs

Chemical Specific ARARs

This alternative is expected to meet the calculated target clean-up levels (TCLs) for soils. The site soils above the TCLs would be excavated and treated at a RCRA incineration facility.

Action Specific ARARs

Action specific ARARs for this alternative apply to the excavation of contaminated soils, monitoring requirements, and transportation, treatment and disposal requirements.

Workers and worker activities that would occur during the implementation of this alternative must comply with the OSHA requirements for training, safety, equipment and procedures, monitoring, recordkeeping and reporting. Also, the RCRA requirements for preparedness and prevention, contingency plans, and emergency procedures would apply to this alternative. Compliance with the above mentioned ARARs would be achieved by following an EPA approved work plan and a site-specific health and safety plan.

The action specific ARARs associated with the incineration and disposal of treated soils at a RCRA facility include the RCRA Standards for Owners/Operators of Permitted Hazardous Waste Facilities (40 CFR 264), the air emission standards contained

in 40 CFR 60, and the Prevention of Significant Deterioration provisions of the Clean Air Act. A permitted RCRA incineration and disposal facility must comply with these actions specific ARARs.

The RCRA and U.S. Department of Transportation requirements for the packaging and transportation of hazardous waste would be applicable to this alternative. Compliance with these ARARs would be achieved by utilizing a licensed hazardous waste transporter.

5.4.6.7 Overall Protection of Human Health and the Environment

The excavation of the site soils and subsequent incineration and disposal of the treated soils at a RCRA facility would meet the soil remedial action objectives. The toxicity, mobility and volume of the soil contaminants would be reduced. Protection of human health and the environment would be achieved by complying with the identified ARARs for this alternative.

5.4.6.8 Cost

The capital cost associated with this alternative include site preparation and restoration and the cost of soil excavation, transportation and incineration. Because of the relatively short implementation period associated with this alternative, operational and maintenance cost are incorporated in the capital cost. Therefore, a present worth analysis has not been performed for this alternative. The estimated cost of this alternative (based on 45,000 cubic yards of soil) is \$100,100,000.00. A detailed breakdown of the estimated cost associated with this alternative are presented in Table 5-11.

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5.5 SUMMARY

A summary of Section 5.0 Detailed Evaluation is provided on Table 5-12.

TABLE 5-1
 SCRDI-BLUFF ROAD SITE
 FEASIBILITY STUDY COST ESTIMATE
 NO ACTION ALTERNATIVE

CAPITAL COSTS
 =====

ESTIMATED COSTS (\$)

NONE

\$0

OPERATIONS AND MAINTENANCE COSTS
 =====

A. Sampling 16 wells, 4 times/year

1. Manpower, 280 hrs/year @ \$25/hr

\$7,000

2. Analysis of 64 samples/year @ \$500/sample

\$32,000

SUBTOTAL

\$39,000

B. Annual maintenance of site (fencing, roads, etc.)

\$500

SUBTOTAL

\$39,500

Contingency @ 25%

\$9,875

Estimated Annual O&M Costs

\$49,375

Present Worth Factor (30 years @ 5%)

15.37

TOTAL PRESENT WORTH

\$758,894

Rounded to

\$760,000

Table 5-2. Ground Water Treatment System
Influent and Effluent Design Basis

Analyte	Inlet to Stripper Worst Case Ground Water Composition ^a (ug/l)	Maximum Allowable In-stream Concentrations ^b (ug/l)
Carbon tetrachloride	80	352 ^c
Acetone	4,428	1100 ^d
Chloroform	1,378	289 ^c
Benzene	110	53 ^c
1,1,1-Trichloroethane	435	528 ^c
Vinyl chloride	13	2 ^d
Methylene chloride	277	1930 ^c
1,1-Dichloroethane	2,551	5 ^d
1,1-Dichloroethylene	443	303 ^c
1,2-Dichloropropane	26	525 ^c
2-Butanone	1,410	550 ^d
1,1,2-Trichloroethane	6	940 ^c
Trichloroethylene	123	5 ^d
1,1,2,2-Tetrachloroethane	122	240 ^c
Ethyl benzene	148	453 ^c
1,2-Dichloroethane	190	2000 ^c
4-Methyl-2-Pentanone	184	550 ^d
Toluene	920	175 ^c
Chlorobenzene	20	192 ^c
Tetrachloroethene	77	84 ^c
1,2-Dichloroethylene	2,222	330 ^c
Xylenes	250	10,000 ^d
1,2-Dichlorobenzene	250	15.8 ^c
1,4-Dichlorobenzene	10	11.2 ^c
2-Chlorophenol	800	43.8 ^c
Phenol	260	256 ^c

^aWorst case recovered water concentrations for treatment system design actual concentrations to be determined during remedial design.

^bClass A stream. Treatment system design effluent concentration limits to be based on maximum allowable in-stream concentrations and the model presented in Section 5.3.4.3 for specific stream.

^cFreshwater (continous) Ambient Water Quality Criteria value.

^dHuman Health based levels (Table 3-2) were used in the absence of Ambient Water Quality Criteria.

TABLE 5-3
 SCRDI-BLUFF ROAD SITE
 FEASIBILITY STUDY COST ESTIMATE
 CARBON ADSORPTION

CAPITAL COSTS	ESTIMATED COST
1. Ground Water Collection System	\$150,000
2. Equalization Tank	\$60,000
3. Pretreatment Equipment	\$175,000
4. Two Dual Bed GAC Adsorption Units (20,000 lbs/bed)	\$400,000
5. Pre-engineered Building	\$171,500
6. Pumps and Piping (mechanical)	\$10,000
SUBTOTAL	\$966,500
Administration and Engineering @ 15%	\$144,975
SUBTOTAL	\$1,111,475
Contingency @ 25%	\$277,869
TOTAL CAPITAL COST	\$1,389,344
Rounded to	\$1,390,000

ANNUAL OPERATIONAL MAINTENANCE COST (O&M)	ESTIMATED ANNUAL COSTS
1. Electricity (20 hp, 15.08 KW, \$0.10/KW-hr)	\$13,200
2. Activated Carbon Regeneration (40000 lb/wk @ \$.45/lb)	\$936,000
3. Labor (20 hrs/week @ \$20/hr)	\$20,800
4. Maintenance & Supplies (3% of Capital)	\$41,700
5. Effluent Monitoring	\$35,000
6. Ground Water Sampling	\$39,000
SUBTOTAL O&M COSTS	\$1,085,700
Contingency @ 25%	\$271,425
Estimated Annual O&M Costs	\$1,357,125
Present Worth Factor (16 yrs, 5%)	10.84
TOTAL PRESENT WORTH OF O&M	\$14,711,235
Rounded to	\$14,715,000
TOTAL ESTIMATED COST	\$16,105,000

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TABLE 5-4
 SCRDI-BLUFF ROAD SITE
 FEASIBILITY STUDY COST ESTIMATE
 AIR STRIPPING

CAPITAL COSTS	ESTIMATED COST
1. Ground Water Collection System	\$150,000
2. Equalization Tank	\$60,000
3. Pretreatment Equipment	\$175,000
4. Two 12', 30" diam. Air Strippers	\$100,000
5. Two Activated Carbon Units	\$50,000
6. Vapor Phase Adsorption System	\$85,000
7. Pre-engineered Building	\$75,000
8. Pumps and Piping (mechanical)	\$10,000
SUBTOTAL	\$705,000
Administration and Engineering @ 15%	\$105,750
SUBTOTAL	\$810,750
Contingency @ 25%	\$202,688
TOTAL CAPITAL COST	\$1,013,438
Rounded to	\$1,013,000

ANNUAL OPERATIONAL MAINTENANCE COST (O&M)	ESTIMATED ANNUAL COSTS
1. Electricity (15 hp, 11.31 kw, \$0.10/KW-hr)	\$9,900
2. Activated Carbon Regeneration (liq. and vapor)	\$100,000
3. Labor (30 hrs/week @ \$20/hr)	\$31,200
4. Maintenance and Supplies (@ 3% of Capital)	\$30,400
5. Effluent Monitoring	\$35,000
6. Ground Water Sampling	\$39,000
SUBTOTAL O&M COSTS	\$245,500
Contingency @ 25%	\$61,375
Estimated Annual O&M Costs	\$306,875
Present Worth Factor (16 yrs, 5%)	10.84
TOTAL PRESENT WORTH OF O&M	\$3,326,525
Rounded to	\$3,326,500
TOTAL ESTIMATED COST	\$4,339,500

TABLE 5-5
 SCRD1-BLUFF ROAD SITE
 FEASIBILITY STUDY COST ESTIMATE
 EFFLUENT DISCHARGE ALTERNATIVES

=====

SUBSURFACE INFILTRATION GALLERY DISCHARGE

CAPITAL COSTS	ESTIMATED COST
-----	-----
1. Equipment & Installation for 3000 sq.ft. of infiltration trenches/piping	\$62,750
2. Markup for Working Conditions (50%)	\$31,375
Administration & Engineering @25%	\$23,531
-----	-----
TOTAL CAPITAL COST	\$117,656

ANNUAL OPERATIONAL MAINTENANCE COST (O&M)	ESTIMATED ANNUAL COSTS
-----	-----
1. Maintenance @ 3% of Capital	\$3,530
Contingency @ 25%	\$882
-----	-----
Estimated Annual O&M Costs	\$4,412
Present Worth Factor (16 yrs, 5%)	10.84
-----	=====
TOTAL PRESENT WORTH OF O&M	\$47,827
-----	-----
TOTAL ESTIMATED COST	\$165,484

=====

MYERS CREEK DISCHARGE

CAPITAL COSTS	ESTIMATED COST
-----	-----
1. Equipment & Installation for 4000 lf of u/g pipeline, w/one pumping station and outfall	\$118,700
2. Markup for Working Conditions (50%)	\$59,350
Administration & Engineering @15%	\$26,708
-----	-----
TOTAL CAPITAL COST	\$204,758

ANNUAL OPERATIONAL MAINTENANCE COST (O&M)	ESTIMATED ANNUAL COSTS
-----	-----
1. Electricity (15 hp, 11.31 KW, \$0.10/KW-hr)	\$9,900
2. Maintenance @ 3% of Capital	\$6,143
Contingency @ 25%	\$4,011
-----	-----
Estimated Annual O&M Costs	\$20,053
Present Worth Factor (16 yrs, 5%)	10.84
-----	=====
TOTAL PRESENT WORTH OF O&M	\$217,379
-----	-----
TOTAL ESTIMATED COST	\$422,136

TABLE 5-5 (Continued)
 SCRDI-BLUFF ROAD SITE
 FEASIBILITY STUDY COST ESTIMATE
 EFFLUENT DISCHARGE ALTERNATIVES

=====	
SURFACE IRRIGATION	
CAPITAL COSTS	ESTIMATED COST
-----	-----
1. Assumes PVC/HDPE surface irrigation piping over 4 acres	\$112,861
2. Markup for Working Conditions (50%)	\$56,431
Administration & Engineering @15%	\$25,394
-----	-----
TOTAL CAPITAL COST	\$194,685
ANNUAL OPERATIONAL MAINTENANCE COST (O&M)	ESTIMATED ANNUAL COSTS
-----	-----
1. Electricity (20 hp, 15.08 KW, \$0.10/KW-hr)	\$13,200
2. Maintenance @ 3% of Capital	\$5,841
Contingency @ 25%	\$4,760
-----	-----
Estimated Annual O&M Costs	\$23,801
Present Worth Factor (16 yrs, 5%)	10.84
-----	=====
TOTAL PRESENT WORTH OF O&M	\$258,000
TOTAL ESTIMATED COST	\$452,685
=====	
CONGAREE RIVER DISCHARGE	
CAPITAL COSTS	ESTIMATED COST
-----	-----
1. Equipment & Installation for 26,000 lf of u/g pipeline, w/4 pumping stations and an outfall	\$1,092,100
2. Markup for Working Conditions (50%)	\$546,050
Administration & Engineering @15%	\$245,723
-----	-----
TOTAL CAPITAL COST	\$1,883,873
ANNUAL OPERATIONAL MAINTENANCE COST (O&M)	ESTIMATED ANNUAL COSTS
-----	-----
1. Electricity (75 hp, 56.55 KW, \$0.10/KW-hr)	\$49,550
2. Maintenance @ 3% of Capital	\$56,516
Contingency @ 25%	\$26,517
-----	-----
Estimated Annual O&M Costs	\$132,583
Present Worth Factor (16 yrs, 5%)	10.84
-----	=====
TOTAL PRESENT WORTH OF O&M	\$1,437,197
TOTAL ESTIMATED COST	\$3,321,069

TABLE 5-6

SUMMARY DESCRIPTION OF SOIL VENTING PROJECTS

Item	Pilot Projects			Full-Scale Projects			
	A	B	C	D	E	F	G
Soil Type	Clayey Silt Silt Clay	Sandy	Sandy Loam	Sandy Loam	Fine, Sandy	Clayey	Clayey Silt
Soil Volume, cy	4,400,000(5)	640	(3)	(3)	1,000-2,000	3,555,000 (est.)	(3)
Total Average VOCs, (mg/kg)							
Initial	up to 5,000	7,650 (4)	50-5,000	50-5,000	8.3-5,000	(3)	(3)
Final	<10 ppb (ND)*	(3)	38-3,7500	(2)	<1	(3)	(3)
Percent Removal	99	(3)	75	(2)	91 to >99	(3)	(3)
Overall Removal Rate (1lb/day)	250 to 860	28-102	22-23	1,000	≈3.5	(3)	(3)
Total Mass of VOCs Removed (lb)	≈11,300	117	1,600	60,000	160	250-300	250
Project Duration	2 months	9 days	14 weeks	60 days	45 days	(3)	(3)
No. of Wells	(3)	4	(3)	80	1 extractions 5 injection	(3)	(3)
Well Spacing (ft)	(3)	11-27	50	(3)	50	(3)	(3)
Well Depth (ft)	300	20-22	(3)	(3)	25	(3)	(3)
Radius of Influence (ft)	(3)	15-25	(3)	(3)	(3)	17	≈35
Vacuum Flow per well (cfm)	150	(3)	50-250	110	10	(3)	18

Notes:

- (1) Includes start-up and operation
- (2) Continuing operation, data unavailable
- (3) Data not reported
- (4) Estimated from data in 1984 Feasibility Study by Baker Engineers
- (5) Includes soil and fractured rock
- (6) Vacuum applied to 1 well; air injected into 5 wells

* ND - not detectable

Projects:

- A - Conf. Client (Ref: Malot and Wood)
 B - Tyson's Site (9-day Prelim. Study) upper Merion Twp, PA
 C - TCAAP; New Brighton, MN
 D - TCAAP; New Brighton, MN
 E - Custom Products; Stevensville, MI
 F - Conf. Client (Ref: Malot)
 G - Conf. Client (Ref: Malot and Wood)

Source: Tysons Site FS, 1986

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TABLE 5-7
SCRDI-BLUFF ROAD SITE
FEASIBILITY STUDY COST ESTIMATE
IN-SITU SOIL VENTING

CAPITAL COSTS	ESTIMATED COST
-----	-----
1. Dual Vacuum Extraction System Well Installation	\$132,000
2. Vacuum Pumps	\$27,000
3. Air Emissions Control (vapor phase carbon)	\$123,000
4. Pilot Test	\$40,000
5. Pre-engineered Building (40'X70' @ \$35/sf)	\$28,000
6. Start-up Operations	\$44,000
7. Operational Costs	\$350,000

SUBTOTAL	\$744,000
Administration and Engineering @ 15%	\$111,600

SUBTOTAL	\$855,600
Contingency @ 25%	\$213,900
	=====
TOTAL CAPITAL COST	\$1,069,500
Rounded to	\$1,070,000

NOTE: Duration of Operations is less than two years. Maintenance for this period is included in operational costs. Present worth not calculated based on estimated duration.

TABLE 5-8
 SCRDI-BLUFF ROAD
 FEASIBILITY STUDY COST ESTIMATE
 INCINERATION

	QUANTITY	UNIT	UNIT RATE (\$)	CAPITAL COST (\$)
I. GENERAL ACTIONS/SITE PREPARATION	-----	---	-----	-----
1. Clearing	2.6 Acre		4000.00	\$10,400
2. Erosion Control	2000 LF		3.00	\$6,000
3. Staging Area Development	300 SY		11.67	\$3,500
4. Equipment Mob/Demob	1 LS		LS	\$20,000
5. Decontamination Facilities	1 LS		LS	\$60,000
6. Stockpile Pad	600 SY		11.67	\$7,000

SUBTOTAL				\$106,900
II. THERMAL TREATMENT				
1. Treatment Unit Mob/Demob and Erection	1 LS		LS	\$1,000,000
2. Soils Excavation and Stockpiling	45000 CY		9.00	\$405,000
3. Thermal Treatment of Solids	72000 Tons		213.00	\$15,336,000
4. Mobile Lab and Air Monitoring	1 LS		LS	\$140,000
5. Health and Safety	1 LS		LS	\$100,000
6. Permitting/Trial Burn	1 LS		LS	\$300,000

SUBTOTAL				\$17,281,000
III. RESIDUALS HANDLING AND SITE CLOSURE				
1. Backfill Excavation	45000 CY		7.50	\$337,500
2. Topsoil Placement	7200 CY		10.00	\$72,000
3. Revegetate	2.6 Acre		2000.00	\$5,200
4. Treated soil stabilization (if necessary)	45000 CY		80.00	\$3,600,000 **

SUBTOTAL				\$4,014,700
				=====
COST ESTIMATE SUBTOTAL				\$21,402,600
Administration and Engineering @ 10%				\$2,140,260

SUBTOTAL				\$23,542,860
Contingency @ 20%				\$4,708,572
				=====
TOTAL ESTIMATED COST				\$28,251,432
Rounded to				\$28,260,000

** Based on current data, stabilization of treated soils is unlikely. The estimated cost for stabilization is shown to provide worst case scenario. Should stabilization be unnecessary, a take out of \$3,600,000 would occur.

TABLE 5-9
 SCRDI-BLUFF ROAD
 FEASIBILITY STUDY COST ESTIMATE
 THERMAL DESORPTION

	QUANTITY	UNIT	UNIT RATE (\$)	CAPITAL COST (\$)
I. GENERAL ACTIONS/SITE PREPARATION	-----	---	-----	-----
1. Clearing	2.6 Acre		4000.00	\$10,400
2. Erosion Control	2000 LF		3.00	\$6,000
3. Staging Area Development	300 SY		11.67	\$3,500
4. Equipment Mob/Demob	1 LS	LS		\$20,000
5. Decontamination Facilities	1 LS	LS		\$60,000
6. Stockpile Pad	600 SY		11.67	\$7,000

SUBTOTAL				\$106,900
II. THERMAL TREATMENT				
1. Treatment Unit Mob/Demob and Erection	1 LS	LS		\$500,000
2. Soils Excavation and Stockpiling	45000 CY		9.00	\$405,000
3. Thermal Treatment of Solids	72000 Tons		106.00	\$7,632,000
4. Mobile Lab and Air Monitoring	1 LS	LS		\$140,000
5. Health and Safety	1 LS	LS		\$100,000
6. Permitting/Trial Burn	1 LS	LS		\$300,000

SUBTOTAL				\$9,077,000
III. RESIDUALS HANDLING AND SITE CLOSURE				
1. Backfill Excavation	45000 CY		7.50	\$337,500
2. Topsoil Placement	7200 CY		10.00	\$72,000
3. Revegetate	2.6 Acre		2000.00	\$5,200
4. Treated soil stabilization (if necessary)	45000 CY		80.00	\$3,600,000 **

SUBTOTAL				\$4,014,700
				=====
COST ESTIMATE SUBTOTAL				\$13,198,600
Administration and Engineering @ 15%				\$1,979,790

SUBTOTAL				\$15,178,390
Contingency @ 20%				\$3,035,678
				=====
TOTAL ESTIMATED COST				\$18,214,068
Rounded to				\$18,250,000

** Based on current data, stabilization of treated soils is unlikely. The estimated cost for stabilization is shown to provide worst case scenario. Should stabilization be unnecessary, a take out of \$3,600,000 would occur.

TABLE 5-10
 SCRDI-BLUFF ROAD
 FEASIBILITY STUDY COST ESTIMATE
 OFF-SITE DISPOSAL

	QUANTITY	UNIT	RATE (\$)	CAPITAL COST (\$)
I. GENERAL ACTIONS/SITE PREPARATION	-----	---	-----	-----
1. Clearing	2.6 Acre		4000.00	\$10,400
2. Erosion Control	2000	LF	3.00	\$6,000
3. Staging Area Development	300	SY	11.67	\$3,500
4. Equipment Mob/Demob	1	LS	LS	\$20,000
5. Decontamination Facilities	1	LS	LS	\$60,000
6. Stockpile Pad	600	SY	11.67	\$7,000

SUBTOTAL				\$106,900
II. CONTAMINATED SOLIDS HANDLING				
1. Soil Excavation and Handling	45000	CY	9.00	\$405,000
2. Truck Loading	45000	CY	2.75	\$123,750
3. Transportation	45000	CY	137.50	\$6,187,500
4. Disposal	45000	CY	200.00	\$9,000,000
5. Mobile Lab	1	LS	LS	\$96,000

SUBTOTAL				\$15,812,250
III. SITE CLOSURE				
1. Backfill with Clean Fill	45000	CY	9.50	\$427,500
2. Backfill with Topsoil	7200	CY	10.00	\$72,000
3. Revegetate	2.6 Acre		2000.00	\$5,200

SUBTOTAL				\$504,700
				=====
COST ESTIMATE SUBTOTAL				\$16,423,850
Administration and Engineering @ 5%				\$821,193

SUBTOTAL				\$17,245,043
Contingency @ 20%				\$3,449,009
				=====
TOTAL ESTIMATED COST				\$20,694,051
Rounded to				\$20,700,000

TABLE 5-11
 SCRDI-BLUFF ROAD
 FEASIBILITY STUDY COST ESTIMATE
 OFF-SITE THERMAL TREATMENT

	QUANTITY	UNIT	UNIT RATE (\$)	CAPITAL COST (\$)
I. GENERAL ACTIONS/SITE PREPARATION	-----	---	-----	-----
1. Clearing	2.6 Acre		4000.00	\$10,400
2. Erosion Control	2000 LF		3.00	\$6,000
3. Staging Area Development	300 SY		11.67	\$3,500
4. Equipment Mob/Demob	1 LS		LS	\$20,000
5. Decontamination Facilities	1 LS		LS	\$60,000
6. Stockpile Pad	600 SY		11.67	\$7,000

SUBTOTAL				\$106,900
II. CONTAMINATED SOLIDS HANDLING				
1. Soil Excavation and Handling	45000 CY		9.00	\$405,000
2. Truck Loading	45000 CY		2.75	\$123,750
3. Transportation	45000 CY		137.50	\$6,187,500
4. Incineration	72000 Tons		1000.00	\$72,000,000
5. Mobile Lab	1 LS		LS	\$96,000

SUBTOTAL				\$78,812,250
III. SITE CLOSURE				
1. Backfill with Clean Fill	45000 CY		9.50	\$427,500
2. Backfill with Topsoil	7200 CY		10.00	\$72,000
3. Revegetate	2.6 Acre		2000.00	\$5,200

SUBTOTAL				\$504,700
				=====
COST ESTIMATE SUBTOTAL				\$79,423,850
Administration and Engineering @ 5%				\$3,971,193

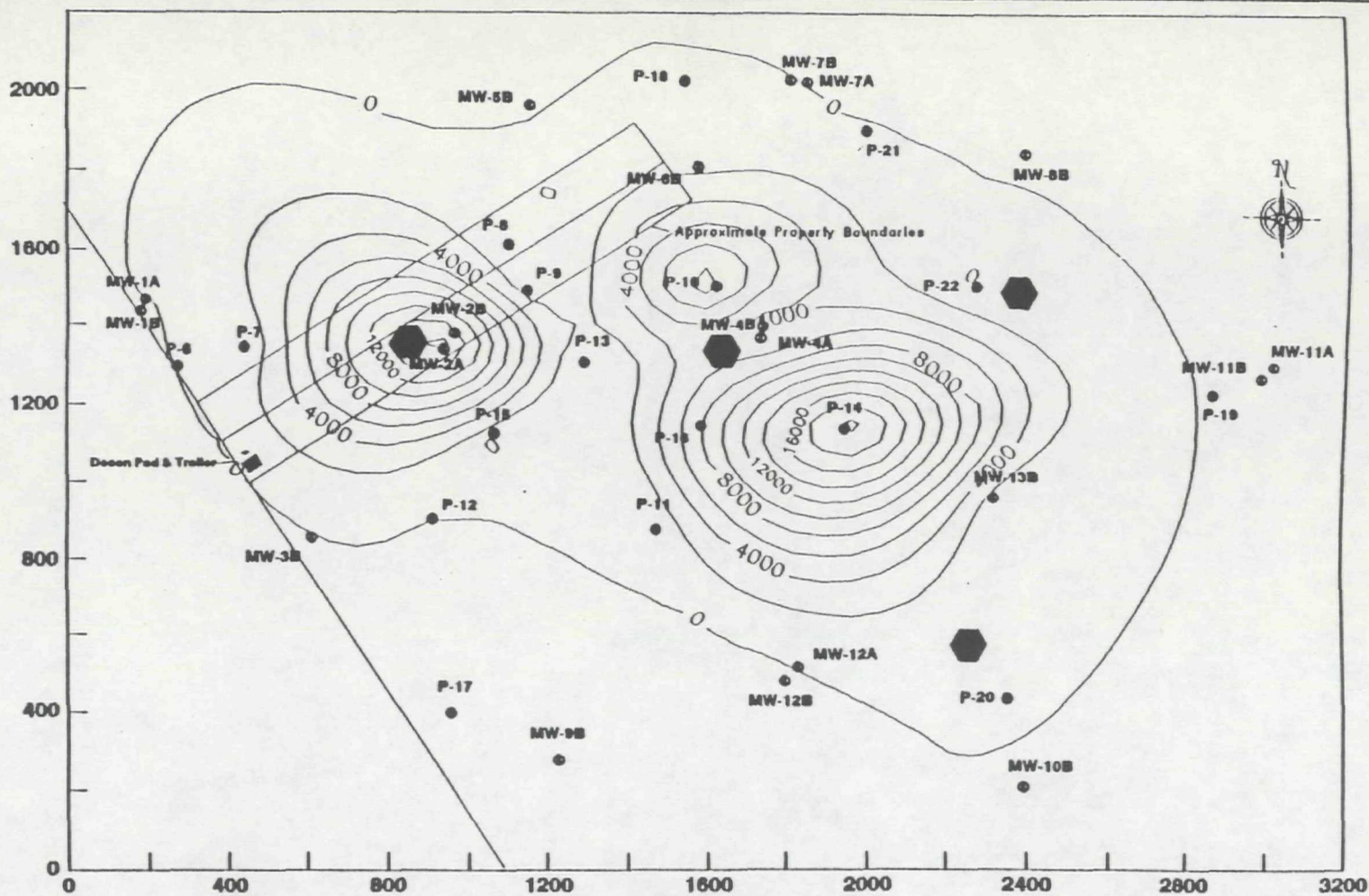
SUBTOTAL				\$83,395,043
Contingency @ 20%				\$16,679,009
				=====
TOTAL ESTIMATED COST				\$100,074,051
Rounded to				\$100,100,000

TABLE 5-12
SCDDI-BLUFF ROAD SITE
FEASIBILITY STUDY
DETAILED ANALYSIS SUMMARY

EVALUATION CRITERIA

Remedial Alternatives	Short-Term Effective	Long -Term Effective	Reduction of Toxicity, Mobility, Volume	Implementable	ARARS	Overall Protection of Human Health and the Environment	Cost
Ground Water							
No Action	NO	NO	No reduction of toxicity, mobility, or volume	YES	Does not meet ARARS	NO	\$ 760,000
Carbon Adsorption	YES	YES	Reduction of toxicity, mobility and volume	YES	Meets or exceeds ARARS	YES	\$ 16,105,000
Air Stripping	YES	YES	Reduction of toxicity, mobility and volume	YES	Meets or exceeds ARARS	YES	\$ 4,339,500
Soil Remedial Alternative							
No Action	NO	NO	No reduction of toxicity, mobility, or volume	YES	Does not meet ARARS	NO	\$ 760,000
In-situ Soil Venting	YES	YES	Reduction of toxicity, mobility, and volume	YES	Meets or exceeds ARARS	YES	\$ 1,070,000
Incineration	YES	YES	Reduction of toxicity, mobility, and volume	YES	Meets or exceeds ARARS	YES	\$ 28,260,000
Thermal Desorption	YES	YES	Reduction of toxicity, mobility, and volume	YES	Meets or exceeds ARARS	YES	\$ 18,250,000
Soil Excavation and Off-site Disposal	YES	YES	Reduction of mobility	YES	Meets or exceeds ARARS	YES	\$ 20,700,000
Soil Excavation and Off-site Thermal Treatment	YES	YES	Reduction of toxicity, mobility, and volume	YES	Meets or exceeds ARARS	YES	\$100,100,000
Ground Water Discharge							
Subsurface Infiltration	YES	YES	N/A	YES	Meets of exceeds ARARS	YES	\$ 165,484
Myers Creek	YES	YES	N/A	YES	Meets or exceeds ARARS	YES	\$ 422,136
Congaree River	YES	YES	N/A	YES	Meets or exceeds ARARS	YES	\$3,321,069
Surface Irrigation	YES	YES	N/A	YES	Meets or exceeds ARARS	YES	\$ 452,685

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LEGEND

- 1000 —
CHEMICAL CONCENTRATION CONTOUR LINE
(Concentration in parts per billion)
- IT WELL (installed 1999)
- GOLDEN WELL (installed 1998)
- GROUND WATER EXTRACTION WELL

SCALE: 1" = 435 ft

NOTE: CONTOUR INTERVAL = 2000 ppb

FIGURE 5-1

POTENTIAL LOCATIONS OF
GROUND WATER EXTRACTION WELLS

SECTION 6.0
POTENTIAL DATA GAPS AND REMEDIAL DESIGN CONSIDERATIONS

The purpose of this section is to delineate potential data gaps and identify key elements for consideration as part of the Remedial Design process. Identified data requirements and recommendations for certain remedial design activities are discussed in the previous sections and summarized below:

1. A detailed pump test for groundwater extraction must be performed to complete the design (i.e., well locations, pumping rates, equipment sizing) for the groundwater treatment system. The wells for the pump test can be installed to evaluate potential interconnection of the surficial aquifer and the deep aquifer, and respond to the SCDHEC concerns with respect to well spacing.
2. The area/volume for possible soil treatment of 45,000 cubic yards is considered a conservative estimate. Good engineering practice dictates use of a conservative evaluation if adequate data are not available to refine the volume estimate. Confirmatory soil sampling is recommended to delineate or fine tune the areas for treatment. Based on experience, it is likely that there are actually two or three discrete source areas resulting from localized spills rather than uniform discharge over a 2.6 acre area. The confirmatory soil work could potentially shorten the duration of treatment of site soils, and reduce the associated cost.
3. Depending on the soils treatment alternative selected, if any, additional RD field work is recommended as a basis for detailed design:
 - For soil venting, additional borings to delineate silt lenses and establish soil gas porosity would enhance and optimize design. As part of this field work a mini-pilot test could be performed to assuage any technical concerns with respect to technology applicability and to further define detailed design criteria.
 - For on-site thermal treatment, an off-site test burn is recommended to establish up front the residuals handling requirements, e.g. metals concentrations in ash and potential subsequent requirement for stabilization. Performing this test prior to RA will enhance design and coordination of site activities (materials handling,

storage, stockpiling, stabilization, etc.) and significantly reduce analytical activities and potential delays associated with data turnaround.

4. As a result of the recent wetlands classification by the Corps of Engineers, of the property adjacent to the SCRDI site, the potential impact of the pump and treat system on the surface hydrology should be established. As discussed in Appendix D, wetland areas could effectively be dried as a result of surficial aquifer pumping. Treatment system design would have to mitigate any impact. This mitigation could either be addressed by reduced pumping rates (i.e., that required to maintain plume containment) or by unique handling of residuals (treated groundwater) for recharge of the wetland surface or subsurface.
5. The design discharge rate for treated ground water will be established during design. This rate will likely be impacted significantly by the wetlands classification. As part of design, the potential impact of downstream flooding of Myers Creek resulting from treated ground water discharge should be evaluated if Myers Creek is chosen as the appropriate discharge option.
6. The surficial aquifer contains significant concentrations of the naturally occurring iron and manganese. The potential deleterious effect of these compounds on any ground water treatment system is substantial. Specific care in design must be taken to address this situation via use of a pretreatment system.
7. If subsurface infiltration is selected as the ground water treatment system effluent discharge alternative, subsurface percolation tests must be performed to establish acceptable application rates (i.e., sizing) to determine whether horizontal or vertical infiltration is most appropriate and to confirm the location for infiltration that will ensure hydraulic control in conjunction with the ground water extraction.
8. If the no action alternative is selected with respect to ground water, the need for an additional ground water assessment should be evaluated to address the potential downward migration of contaminants to the deep aquifer.

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